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Concerning Oligocene Amphisbaenid Reptiles

BY

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ABSTRACT: The paper deals with the amphisbaenid fauna of the Orellan, Middle Oligocene of Logan County, Colorado, and with a single species from the Orellan of Converse County, Wyoming. The following species are described: *Hyporhina galbreathi sp. nov., Rhineura anblyceps sp. nov., Rhineura hibbardi sp. nov., Rhineura wilsoni sp. nov., Gilmoreia attenuatus gen. et sp. nov.* The family Hyporhinidae is recognized for the genus *Hyporhina,* and the family Crythiosauridae is proposed for a Mongolian genus *Crythiosaurus.*

INTRODUCTION

The amphisbaenid reptiles have been variously treated by previous authors. They have been regarded as a Family, as a Superfamily, and as an Infraorder under the Lacertilia (Sauria); as a Suborder of equal rank with the Sauria, and even as a reptilian Order. Some authors have placed all the known species in a single family, the Amphisbaenidae; while others have found it convenient to recognize several families. More than 30 genera have been named.

This aberrant group of vertebrates appears to stand, in relation to the other living Reptilia, much as do the Gymnophiona to other living Amphibia; and it is doubtful that the differences from Caudata or other Amphibia displayed by the Gymnophiona are more significant than those that obtain between the Amphisbaenia and the other groups of the Reptilia. I am strongly inclined toward a recognition of these considerable differences by placing them in an Order of their own. A discussion of the matter is, however, not the primary concern of this paper. Romer (1932) considers them of Subordinal rank, as do Smith and Taylor (1950). These authors are followed here.

There is considerable difference of opinion as to the validity of many of the genera proposed for the living species, and the number recognized varies much with different authors. Loveridge (1940)

has recently reviewed the African genera, recognizing *Trogonophis, Pachycalamus, Agamodon, Baikia, Blanus, Amphisbaena, Placogaster, Geocalamus, Monopeltis* and *Dalophia.** Laurent has recently revived two genera *Chirindia* and *Cynisca* placed by Loveridge in the genus *Amphisbaena.* He describes a new genus *Tomuropeltis,* thus bringing the total African genera to 13.

The American genera *Bipes,* Mexico, *Rhineura,* Florida and Oligocene of Colorado, etc., *Lepisternon* Brazil, *Bronia* Brazil, *Aulura,* Brazil, *Anopsibaena,* Brazil, *Mesobaena,* Venezuela, *Diphalus,* Virgin Islands, *Cadea,* Cuba, are probably all recognizable genera. However, the generic names *Chirotes, Hemichirotes, Euchirotes* and *Bimanus* of Mexico should doubtless be treated as synonyms of *Bipes.* I am uncertain as to the status of *Aporarchus, Sarea, Monotrophis Cephalopeltis* and *Ancylocranium.*

Four genera known only from fossils are recognized. These are *Hyporhina, Ototriton, Crythiosaurus* and *Gilmoreia* (the latter herein described).

The question of the number of living families in the amphisbaenids is likewise unsettled. I regard the families Amphisbaenidae, Bipedidae and Trogonophidae (for the acrodont group) as valid. It is not impossible that certain other groups of species merit family status. All of the previously known American fossil forms except *Hyporhina* are presumably referable to the Amphisbaenidae. I consider *Hyporhina* worthy of family rank under the name Hyporhinidae based primarily on the presence of the postorbital bone. While the anatomy of the Mongolian genus *Crythiosaurus* is not wholly known, the characters given seem to warrant the erection of the family Crythiosauridae, the characters being those of the genus.

It is possible that *Ototriton* belongs to still another family. Camp, Taylor and Welles (1942) placed *Ototriton* in the Dolichosauridae and *Lestophis* (the latter known only from vertebrae) in the Sauria.

The Amphisbaenia represent a group of vertebrates that now have become highly specialized for subterranean life by total or partial loss of limbs, and the aquisition of a serpentine form. Because of this they have survived long after the extinction of their more generalized terrestrial tetrapod ancestors. One may conceive of a populous tetrapod suborder (or order) existing in the past, and practically worldwide in distribution, that had diversified into several families. Competition for food, probably among terrestrial

* The listing of the genus *Dalophis* (Loveridge 1941, p. 357) for *Dalophis jallae* and *Dalophis pistillum* is an error. These are properly *Dalophia,* and are so treated elsewhere.

members of the same order, forced certain forms in several families to seek underground food. It is presumed that later the terrestrial generalized forms succumbed to competition with members of other orders.

Counterparts of these happenings are suggested in the Order Gymnophiona of the Class Amphibia. Here only the limbless burrowing forms have survived. In the Order Caudata, members of certain suborders have survived probably because of their subterranean habitat (Suborder Meantes). In other suborders certain of the less specialized forms still exist. In the Mutabilia a few species have become subterranean, while many of the families retain the generalized terrestrial tetrapod form.

Similar surviving groups occur in the Sauria. The families Anelytropidae, Feylinidae, Dibamidae, Anniellidae, and Pygopodidae all are regarded as burrowing survivors of former terrestrial groups in which only relict forms are now known. In the following families only a part of the members have taken on a serpentine form and become subterranean: Scincidae (*Brachymeles* and several other genera), Zonuridae (*Chamaesaura*), Anguidae (*Ophisaurus*), and Tejiidae (*Scolecosaurus*). In certain other genera this process of specialization is already begun.

Certain characters in which Amphisbaenia differ completely (or partly) from Sauria are:

1. Mode of progression (progression is made largely in a straight line by slight vertical undulations).
2. Loss or reduction of the right lung, rather than the left.
3. Absence of evidence in the skull of a pineal* or parietal eye.
4. Absence of skull arches.
5. Annulation of body.
6. Absence of most of the dermal bones of the orbital ring.
7. Overlapping (telescoping) of bones.
8. Phalangeal formula when present 3-3-3-3-3 instead of the more typical 2-3-4-5-3.
9. A greater development of chondral elements in the skull.

The known fossil history of the Amphisbaenia on the North American continent begins with the discovery of *Ototriton solidus* Loomis in the early Eocene (Wasatchian). Even in the Eocene it would appear that the group had already undergone a long evolution. *Ototriton solidus* is one of the largest species of the group judging by the skull that measures 31.5 mm. in length and 23.5 mm. in

* Reported as present by Gilmore and Jepsen (1945); said to be absent by Zangerl (1944). I suspect that the opening on the median line between the supraoccipitals and parietal of *Hyporhina* should not be interpreted as that of a pineal eye.

width, a size that is reached by only a few species living today. It already displays most of the expected characteristics of amphisbaenids, as well as its own peculiar specializations. Another species *Ototriton minor* is about half as large. Two other forms from the Middle Eocene, based on vertebrae alone, have been referred to the genus *Lestophis,* a genus of doubtful status.

Passing over the Upper Eocene where specimens are as yet unknown, we find several species and genera present in the Oligocene. Above the Oligocene another great gap in our knowledge occurs, and no specimen is known from the Miocene, the Pliocene, or the Pleistocene. In the Recent however five living forms, belonging to two genera, *Rhineura* and *Bipes,* are known on the North American continent and one other genus, *Amphisbaena,* with four or more species, occurs in the West Indies. Thus the probability is strong that Amphisbaenids were present and will eventually be found as fossils in the three periods that have as yet no known species.

Some time ago three Amphisbaenid specimens in the paleontological section of the University of Kansas Museum of Natural History were placed in my hands for study by Dr. R. W. Wilson, Associate Curator of Paleontology, University of Kansas, and Mr. Edwin C. Galbreath of that Institution. These specimens were found in the summer of 1946 by a party consisting of Richard Rinker, Joao Moojen, Edwin C. Galbreath, Theodore Downs, Russell R. Camp, and Henry Hildebrand, under the direction of Dr. Claude W. Hibbard, while investigating Oligocene faunas of Logan County, Colorado. The three specimens represent the first† reported finds of amphisbaenids in the Oreodon Zone of Logan County, Colorado. A number of other remains taken at the same time pertain to reptiles of other groups and these are to be reported at a later time.

Through the courtesy of the authorities of the University of Colorado Museum, I have obtained a loan of an amphisbaenid skull collected by Dr. R. W. Wilson in 1940 at the same locality as those collected by the University of Kansas party in 1946.

Through the courtesy of Dr. Lewis B. Kellum and Dr. Claude Hibbard of the University of Michigan Museum of Paleontology, I have had available for study three Amphisbaenid skulls from Logan County, collected by Dr. Hibbard and party in 1948. A single specimen of an Amphisbaenid skull from the Oligocene of Wyoming was loaned by Dr. C. Lewis Gazin of the U. S. National Museum.

† One specimen consisting of a vertebra taken in 1873 from the Horsetail Creek Beds (Titanotherium Beds, Horizon A) of Logan County, was described by E. D. Cope as *Platyrachis coloradoensis.* Cope did not recognize the relationship of the specimen to the amphisbaenids and it remained for Gilmore (1928) to transfer the form to the genus *Rhineura.*

Mr. Galbreath in 1948 acquired four other skulls in the Logan County area which he presented to the University of Kansas. These also have been available for study.

I am of the opinion that certain of the specimens represent undescribed species. One of these is being placed in the genus *Hyporhina* Baur and certain ones are being placed in the genus *Rhineura*. One is regarded as representing a new genus.

Of the genus *Rhineura,* aside from a living species in peninsular Florida, four fossils forms are recognized: these are *Rhineura hatcheri* Baur, *Rhineura minuta* Gilmore, *Rhineura sternbergii* Walker, all based on adequate material. A fifth species *Rhineura coloradoensis* (Cope) (based on *Platyrachis coloradoensis* Cope) may be regarded as being of uncertain status; and until its vertebrae are found associated with a skull, its relationship to the species here described cannot be ascertained.

The following outline presents data on the geological and geographical distribution of North American amphisbaenids.

KNOWN GEOLOGICAL DISTRIBUTION OF THE AMPHISBAENIA IN CONTINENTAL NORTH AMERICA

Recent (Living forms)*			*Rhineura floridana* (Baird), *Bipes biporus* (Cope), Baja Calif, Mex. *Bipes canaliculatus* (Bonneterre), Guerrero, Mex. *Bipes tridactylus* (Dugès), Guerrero, Mex. *?Bipes sp.* Arizona
Pleistocene (Unknown)			
Pliocene (Unknown)			
Miocene (Unknown)			
Oligocene	Late.	Whitneyan, Upper Brule (Leptauchenia Zone)	*Rhineura hatcheri* Baur *Hyporhina antiqua* Baur
	Middle.	Orellan, Lower Brule (Oreodon Zone)	*Rhineura sternbergii* Walker *Rhineura minuta* Gilmore *Rhineura hibbardi sp. nov.* *Rhineura wilsoni sp. nov.* *Rhineura amblyceps sp. nov.* *Rhineura hatcheri* Baur *Hyporhina galbreathi sp. nov.* *Gilmoreia attenuatus sp. nov.*
	Early.	Chadronian (Titanotherium Zone)	*Rhineura coloradoensis* (Cope)

* These species were originally described as *Lepidosternon floridana, Bipes canaliculatus, Euchirotes biporus* and *Hemichirotes tridactylum.* Another species probably occurs. (see James in Long's Expedition to the Rocky Mountains, vol. 1, 1823, p. 484; Taylor, Copeia, 1938, no. 4, Dec. 10, p. 202.)

Eocene	Late.	(Unknown)	
	Middle.	Bridgerian, Bridger, Black's Fork member	*Lestophis anceps* (Marsh) Uinta Co., Wyo. *Lestophis crassus* (Marsh) Uinta Co., Wyo.
		Wasatchian, Wind River, Lost Cabin member	*Ototriton minor* Gilmore and Jepsen, Natrona Co., Wyo.
	Early.	Wasatchian, Wind River, Lysite member	*Ototriton solidus* Loomis, Fremont Co., Wyo.

GEOGRAPHICAL DISTRIBUTION OF OLIGOCENE AMPHISBAENIDAE

Whitneyan (Leptauchenia Zone)	Battle Draw Springs, Washington Co., S. D.	*Rhineura hatcheri* Baur *Hyporhina antiqua* Baur
Orellan (Oredon Zone)	Sioux Co., Neb.	*Rhineura hatcheri* Baur
	Washington Co., S. D.	*Rhineura hatcheri* Baur
	Douglas, Converse Co., Wyo.	*Rhineura sternbergii* Walker *Rhineura minuta* Gilmore *Gilmoreia attenuatus sp. nov.*
	Logan Co., Colo.	*Hyporhina galbreathi sp. nov.* *Rhineura hibbardi sp. nov.* *Rhineura amblyceps sp. nov.* *Rhineura wilsoni sp. nov.* *Rhineura hatcheri* Baur
Chadronian (Titanotherium Zone)	Logan Co., Colo.	*Rhineura coloradoensis* Cope

In the preparation of this paper I am under deep obligation to Dr. Robert Wilson and Mr. Edwin Galbreath for assistance with the stratigraphic nomenclature, and for reading and criticizing the manuscript.

Dr. Byron Leonard has kindly prepared the photographs of the skulls reproduced here. For this I am indeed grateful.

SYSTEMATIC TREATMENT

A total of fourteen skulls have been available in this study. They vary considerably in completeness and state of preservation. All but one of these are from the Orellan (Oreodon Zone) of Logan County, Colorado. This single species is from the Orellan of Converse County, Wyoming, likewise the type locality of *Rhineura*

minuta and *Rhineura sternbergii,* and is here described as a new genus and species.

KEY TO SYMBOLS USED IN THE TEXT FIGURES

BO	Basioccipital	OS	Orbitosphenoid
BS	Basiphenoid	OT	Otic
C	Coronoid	P	Parietal
CB	Corpora bigemina	PA(L)	Palatine
CH	Cerebral hemisphere	PF	Prefrontal
D	Dentary	PM	Premaxilla
EC	Extracolumella	PO	Paroccipital (in *Rhineura*)
EO	Exoccipital	PO	Postorbital (in *Hyporhina*)
EP	Epipterygoid	PT	Pterygoid
F	Frontal	PV(V)	Prevomer
FM	Foramen magnum	Q	Quadrate
FO	Fenestra ovale	S	Stapes
M	Maxillary	SA	Surangular (Supraangular)
N	Nasal	SCC	Semicircular canal
O	Orbit	SO	Supraoccipital
OCO	Occipital condyle	SQ	Squamosal
OLL	Olfactory lobe		

GILMOREIA *genus novum*

A genus of fossil Amphisbaenid reptile characterized by a shallow or absent orbital vacuity, not overhung by the frontal bone; elevated portion of skull much narrowed, its surface smooth, lacking sculpture. Section of skull posterior to its highest point much shortened; no postfrontal; dental characters unknown. Type species *Gilmoreia attenuatus.*

Gilmoreia attenuatus sp. nov.

Plate LVIII, figs. 3, 4, 5; text fig. 1, a, b, c.

Type.—United States National Museum, No. 16308 (field No. 40), consisting of a skull, the anterior part, from about the middle of the frontals, missing. The quadrate, extracolumella, pterygoid, palatine, prevomer, and entire lower jaw missing.

Type locality.—Eight miles east of Douglas, Converse County, Wyoming. G. F. Sternberg, collector, 1931.

Horizon.—Oligocene, Brule.

Diagnosis.—The deflected portion of the skull is much longer than the remainder. The length from the anterior edge of the foramen magnum to the highest elevation of the skull is less than the median length of deflected portion of the parietal. The skull is attenuated anteriorly, its narrowest width being considerably anterior, not posterior, to the point of highest elevation. The diamenter of the brain cavity at the anterior level of the basioccipito-sphenoid

bone, is proportionally much larger than in *Hyporhina* or *Rhineura*. The outline of the squamosal is completely obliterated, the point of articulation for the quadrate, however, strongly projecting. The bones of the facial portion of the skull lacking sculpturing.

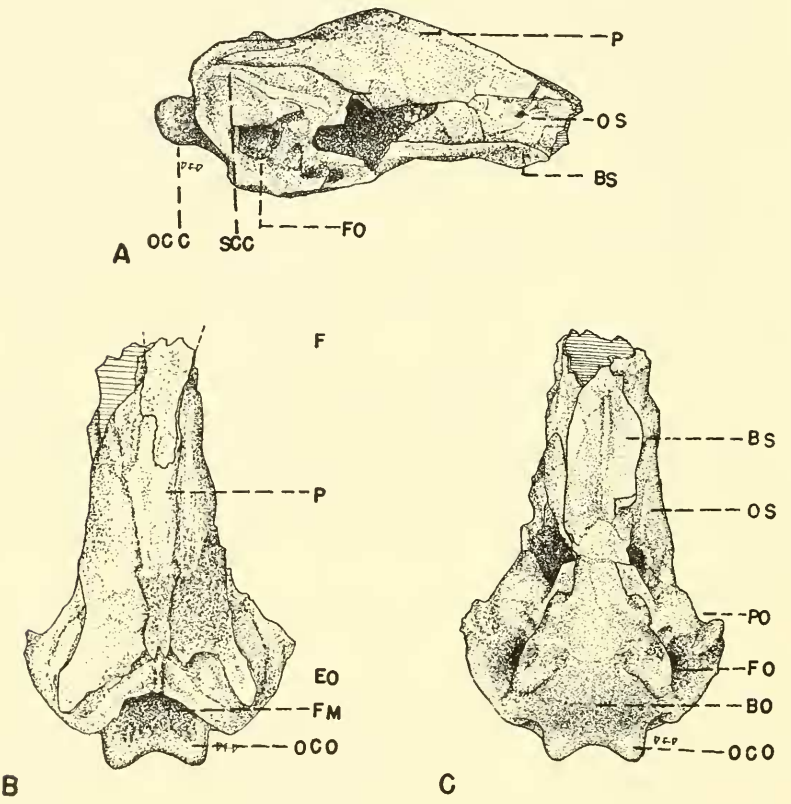

FIG. 1. *Gilmoreia attenuatus gen. et sp. nov.* Type, U. S. Nat. Mus. No. 16308 (original No. 40). Oligocene, Orellan (Brule), 8 m. N Douglas, Converse Co., Wyoming. G. F. Sternberg, collector, 1931. A. Lateral view; B. Dorsal view; C. Ventral view. Actual length of fossil 7.5 mm.

Description of type.—The greatest width of the moderately inflated posterior part of the otic region of the skull (4.5 mm.) is slightly greater than the length of the skull from the posterior edge of the condyles to the level of the highest point (4.25 mm.); the foramen magnum opens dorsally or, perhaps better, postero-dorsally.

The frontal bones are largely missing; their posterior ends, partially separated by a tongue from the parietal, are narrow, their

length nearly twice their width. The width of the frontal at the farthest (lateral) extension of the parietal is about 1.1 mm. It is presumed that this point is posterior to the middle of the total length of the frontal and that there is a very slight widening on the anterior terminal portions of the skull as is typical of certain living genera (*Amphisbaena, Bipes*).

The parietal is large, somewhat saddle-shaped and covers the greater part of the posterior dorsal surface of the skull, overlapping very considerably the deeper bones of the posterior part of the brain case, leaving only a very narrow rim of the supraoccipital and the posterior parts of the otic region bordering the foramen magnum. The foramen magnum tends to notch the parietal, the posterior parts appearing as two broadly rounded lobes. On the median line a short sagittal ridge arises from the main bone, projects back to dovetail on the median line with a very narrow median crest of the supraoccipital. The parietal also covers the greater portion of the lateral surface of the brain case terminating anteriorly in a point. This forward extension is visible along the elevated dorsal surface as a very narrow line, bordering the outer edge of the frontal (broken away on left side).

The supraoccipital, exoccipital, basioccipitals, and the otic capsule are fused into a single element, the former sutures now being completely obliterated. In the otic regions the two dorsal semicircular canals of the ear are clearly visible as two slightly elevated whitish ridges which meet nearly at a right angle at a point lateral to the foramen magnum where it is widest. The third canal is partly indicated on the posterior face of the skull.

The fenestra ovale is irregularly oval, and the stapes is present on the left side, though sunken more deeply than is normal. The columellar part is largely missing, only the basal portion remaining.

Overhanging the anterior edge of the fenestra ovale is the facet for the articulation of the quadrate. Presumably the squamosal is completely fused with the outer part of the otic region. In most cases the fusions in the skull are of chondral bone to chondral bone; here it would appear that the fusion is of dermal bone to chondral bone if the squamosal has even been present.

A short distance in front of the fenestra ovale is the longitudinally oval opening along the side of the brain case characteristic of the amphisbaenids, having an area exceeding that of the fenestra ovale; its upper posterior border is formed by the fused prootic. Beginning near the middle of the upper border is the orbitosphenoid that runs

forward forming a suture with the basal part of the brain case, the fused basisphenoid (parasphenoid). The anterior extension of the orbitosphenoid is broken away. A small foramen is evident in the bone and two canals can be discerned radiating from it. It would appear that the orbital vacuity is absent or if present is very shallow and has been moved far forward in comparison with that of *Rhineura.*

The basioccipital-exoccipital region bears a transverse dumbbell-like condyle, the two outer knobs being much wider than the median portion. It is presumed that both exoccipitals and basioccipital bones contribute to the condyle. Seen directly from behind the condyle occupies a position about mid-distant between top and bottom and its transverse length equals one third of the greatest width of the brain case. Directly lateral to the condyle knobs and closely approximating them are large nerve foramina.

Seen from the ventral surface, anterior to the condyles are two roughened elevated areas, the outer edges of which lie just below the fenestra ovale. Presumably they mark the original positions of the paroccipital* bones that are now missing. Somewhat farther forward, on the outer edge of the bone are notches marking point of contact with the posterior end of the missing pterygoid. Just anterior to the level of the notches the bone has been broken, but anterior to the break it continues forward, having the appearance of a spearhead. Toward its anterior end a saggittal ridge develops. The anterior part of the bone is absent.

Measurements in mm.—Actual length of fossil, 7.5; estimated skull length, 10; greatest width of brain case (otic region), 4.5; narrowest width at level of posterior point of frontal, 1.5. From highest elevation to foramen magnum, 2.7; from highest point to end of condyle, 4.3; from highest point to the anterior end of parietal, 4.15; to posterior end of parietal 4.1.

Remarks.—The aberrant character of the species *Rhineura minuta* described by Gilmore (Proc. U. S. Nat. Mus., vol. 86, 1938, pp. 12-14, fig. 1) strongly suggests that the relationships might better be shown by regarding it in a genus apart from *Rhineura.* The characters which appear to separate the species from *Rhineura* are those in which *Rhineura* differs from *Gilmoreia.* These are the absence of a wide flaring deflected facial portion, the lesser angle of deflection, the narrow, sharp-edged elevation on the dorsal surface lacking an overhanging edge, the smooth character of the anterior

* In the figure, the legend "PO" is not connected with the paroccipital.

dorsal part of the skull. In consequence there is a probability that *minuta* may eventually prove to be a member of the genus *Gilmorcia.*

The type locality of *G. attenuatus* is also the type locality of two other species of amphisbaenids, *Rhineura minuta* Gilmore and *Rhineura sternbergii* Walker. Since my skull is incomplete and the other two practically complete, many points of comparison are lacking. Based on the skull characters given by Gilmore and the accompanying figures, *Gilmorcia attenuatus* differs from *Rhineura minuta* in being large, estimated length, 10 mm. (7.8 mm.). The greatest width of the brain case 4.5 mm. (3.3 mm.); width at orbits 1.5 mm. (?) (2.9 mm.); least width 1.5 mm. (1.6 mm.). (The measurements of *minuta* in parenthesis.) In *G. attenuatus* the skull seen in lateral profile has the posterior part of the brain case nearly horizontal then it suddenly rises to the highest point then slopes gently (not curves) downward. In profile the dorsal outline of *minuta* seems to curve from the foramen magnum to snout tip, not reaching or forming an angular elevation. The transverse width of the condyle is equal to one third of the total width of the brain case. In *R. minuta* neither the size of the condyle nor its position are given in the description. However, the figure shows the transverse width of the condyle to be one half of the width of the skull and situated lower than in *attenuatus.*

Characters on which the two species agree are, the smooth surface of dorsal elevated part of skull; the narrowness of the elevated skull part; and absence of the overhanging wings of the parietal and frontal.

Compared with *Rhineura sternbergii,* the angle of defflection is less sharp and the depth of the skull at the highest point is seemingly less. The length of the posterior part of skull (highest point to end of condyle) is 4.3 mm.; from highest point to anterior extension of the parietal, 4. 15 mm.; while in *sternbergii* the distances from highest point to condyle end is practically double the extension of the parietal from the highest point forward.

Genus HYPORHINA Baur

Hyporhina Baur, American Naturalist, vol. 27, 1893, pp. 998-999.

Type species.—Hyporhina antiqua Baur.

This genus has been established on the following characters:

A postorbital arch formed by a postorbital bone; prefrontal small excluded from the boundary of orbit by the frontal and maxillary; nostril ventral to snout; four acrodont teeth in each maxillary; pre-

maxillary, nasals and frontals nearly meeting at a point near tip of snout.

A specimen of a small amphisbaenid from the Middle Oligocene of Logan County, Colorado, belongs in this genus. It bears some points of resemblance to, and numerous differences from, *Hyporhina antiqua* from the Middle Oligocene, Washington County, South Dakota. There is a postorbital arch closing the orbit of the eye; and the frontals, nasals, and prefrontals almost meet at a point near the tip of the snout. The contour of the skulls are in general similar; however, the angle of deflection in the Colorado skull is somewhat less than in *Hyporhina antiqua.* The two most significant differences are that the prefrontal bone is much larger than in *Hyporhina antiqua* forming at least one third of the border of the orbit, and there are six pleurodont maxillary teeth on each side, instead of four "acrodont" teeth. The original description does not mention this dental character but Charles W. Gilmore who studied the type says: "The teeth appear to be acrodont."

If the teeth of *Hyporhina* are indeed acrodont one may doubt the wisdom of considering this form with pleurodont teeth as belonging to the same genus. Such a dental character is considered very significant, serving in Lacertilia to distinguish the two lizard families Agamidae and Iguanidae from each other. Until the character of the teeth of *Hyporhina antiqua* can be established as acrodont beyond question, I shall consider the present species as congeneric with *Hyporhina antiqua.*

Hyporhina galbreathi sp. nov.

Plate LVIII, figs. 6, 7, 8; Plate LIX, figs. 4, 5; text figs. 2, 3

Type.—University of Kansas Museum of Natural History, Paleo. No. 8221, consisting of a skull, complete save for the absence of the quadrate and a part of the squamosal. The lower jaw is absent. Collected under the direction of Dr. Claude W. Hibbard, University of Kansas Museum of Natural History Expedition of 1946.

Type locality.—Clyde Ward Ranch, Logan County, Colorado, July 31, 1946.

Horizon.—Middle Oligocene (Orellan), White River Formation.

Diagnosis.—A species, related to *Hyporhina antiqua* Baur, but differing from this form in having two spinelike lateral processes on the anterior part of the parietal (not protruding); in having a much larger prefrontal forming more than one third of the border of the orbit, rather than a small one completely separated from the

orbit; six maxillary teeth present that are definitely pleurodont, rather than four that are regarded as acrodont.

Description of the type.—The skull is diminutive (8.5 mm. long), the frontal portion strongly deflected and wider than the posterior part of the braincase. The premaxilla seen from above has a curved surface, subtriangular in shape, about a third greater in its transverse width than in its length. Posteriorly it is in contact with the

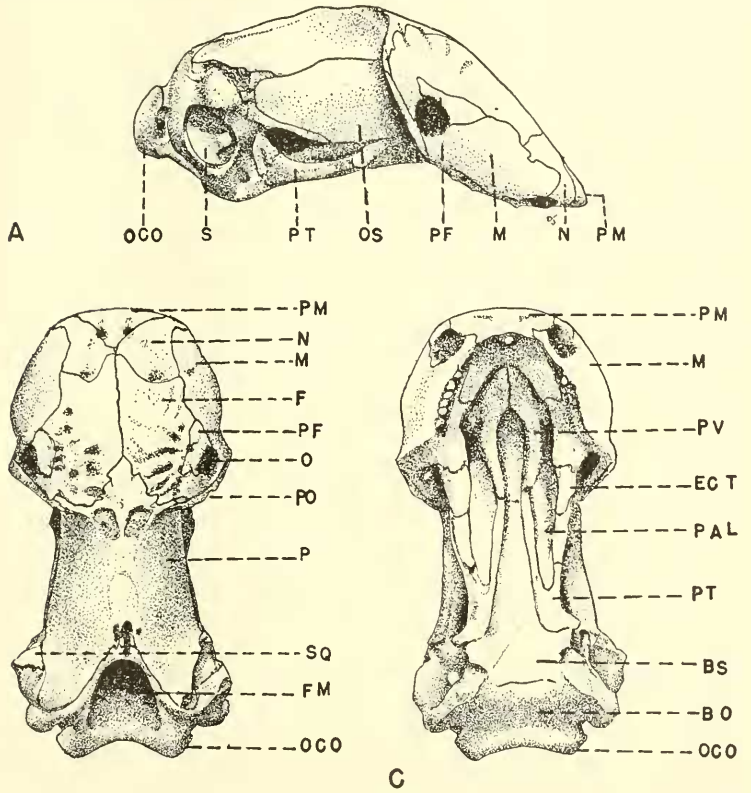

FIG. 2. *Hyporhina galbreathi sp. nov.* Type, Kansas U. Mus. Nat. Hist., Paleontology No. 8221. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, July 31, 1946. A. Lateral view; B. Dorsal view; C. Ventral view. Actual length of fossil 8.5 mm.

nasals. When seen from below, it presents a flattened surface external to the mouth, with two rather shallow diagonal grooves. When seen laterally the snout is rather wedge-shaped. Latero-posteriorly the element is bordered by the external nares, and its edge is notched on each side by the tip of the maxillary process,

which forms the inner rim of the naris. Medially, nearly in a line between the nares but at a different level, is a single tooth arising from the premaxilla within the edge of the buccal cavity. Behind this the premaxilla sends out two divergent processes that pass along the sides of the anterior part of the maxillary tooth rows on a level with the bases of the teeth, and are separated by the anterior part of the prevomers.

On the dorsal surface of the skull the nasals are narrowly in contact mesially, from which point they diverge and pass forward narrowing greatly, then widening somewhat as they turn outward and under the edge of the snout to form the anterior border of the nares. Small foramina are present on the naso-frontal border as well as on the naso-premaxillary border. The paired frontals are large, about twice as long as wide, separated narrowly from the premaxillary, and in contact with each other along a straight median suture for more than half their length. Posteriorly the bones have a lateral process that extends downward to and forms a part of the posterodorsal rim of the orbit. Seemingly they are in contact with the maxillary by a very narrow pointed process posterior to the orbit. The posterior parts of the frontals are heavily sculptured with pits, foramina, and shallow grooves, while the anterior part is shallowly and indistinctly sculptured. The maxillary bone is longer than wide, forming the lower part of the orbit. It folds under the lateral edge of the snout to the alveolar edge and forms a considerable area on the underside of the skull. The teeth are pleurodont in character and are set well back under the bone. There are six maxillary teeth, the largest being the second from the front.

The prefrontal is a small element lying somewhat above and in front of the orbit, and forming more than one third of the border of the orbit. The postfrontal is a slender bone inclosing the orbit and fitting into a notch in the parietal, dorsally, and into a similar notch in the maxillary, ventrally.

The single parietal is an extensive saddle-shaped bone, the anterior triangular part being elevated, and deflected downward slightly. It pushes in between the posterior parts of the frontals. A spinous process is present on each side at a level with the posterior edge of frontal, touching the postorbital bone and bordering the posterior edge of the frontal. At the highest part of the skull there are two symetrical, roughened depressions on the parietal narrowly separated medially, which presumably serve for muscle

attachments. Posteriorly the parietal sends back two broad processes which diverge and reach rather close to the posterior level of the condyle. Laterally the parietal is in contact with the otic region, the squamosal and the orbitosphenoid.*

The supraoccipital seemingly is fused with the exoccipitals the basioccipital, and the bones of the otic capsule, so that none of the individual elements are discrete. The combined element forms the border of the foramen magnum, becoming thicker and more massive on the sides. The posterior rim of the foramen bears the occipital condyle, on each side of which is an articular knob. The exoccipital area of the combined bone is thick and massive, with a forward directed part that is closely joined to the squamosal and lies above the ear opening. The squamosal appears as an "inlay" bone on top of the otic region and is wedged in between the posterior part of the parietal and the orbitosphenoid. A portion of the combined occipital bone (prootic?) appears directly in front of the squamosal.

The orbitosphenoid is a large bone, reaching forward from the squamosal to the anterior edge of the orbital vacuity and forming the cranial wall on the side of the skull. On the floor of the orbital vacuity it is in contact with a section of the frontal.

The stapes covering the fenestra ovalis is oval in shape with a cylindrical columella extending outward and forward. There is no trace apparent of an extracolumellar element, although one may have been present originally.

No trace of the division between the exoccipitals and basioccipital is evident. The latter bone slants forward and downward. The suture between this element and the basisphenoid (parasphenoid of Zangerl) is faintly evident at a point 1.8 mm. anterior to the median depression between the condyles. The basisphenoid is notched laterally at the point where its widest point narrows suddenly to half its width and proceeds forward, the sides converging anteriorly. Here it contacts (passes above) the vomers which extend forward to the median point of the premaxillaries. Two roughened areas on either side of the posterior part of the basisphenoid may represent the position of the missing paroccipitals ("element X" of Zangerl).

The prevomers form a median suture anteriorly for about 1.15 mm. then diverge, the two branches bordering the anterior part of

* The nomenclature of this element may be questioned. Gilmore calls it the alisphenoid but it appears to be more properly the orbitosphenoid, or a combined element. However, there is no evidence that an optic foramen is present.

the parasphenoid (presphenoid?), which is slightly deflected downward and has a median ridge. The prevomers also contact the anterior part of the pterygoids and the palatines laterally. The pterygoids are narrow anteriorly, and extend back, passing to some distance behind the palatines, where each sends up a small lateral process that reaches almost to the stapes. External to the palatines the pterygoids contact the ectopterygoid. The palatines occupy the depressed area between the maxilla and the ectopterygoid on the outside, and the vomerine process and the pterygoid on the inside.

Measurements in mm.—Greatest length, 8.5; greatest width of braincase, 4; greatest width of deflected frontal area, 4.4; narrowest skull width, 2.8; greatest elevation (without lower jaw), 3.8.

Remarks.—As already stated, this specimen differs from the generic description in having more than four teeth on the maxillary, and in having the prefrontal forming a large part of the boundary of the orbit (more than one third). In appearance there is such a striking general similarity in form that I am inclined to place the species in *Hyporhina* at least for the present.

It is generally accepted that the Oreodon (Orellan) beds of the White River formation in northeastern Colorado are older than the Leptauchenia (Whitneyan) beds of South Dakota. It would then appear that this species is older than *Hyporhina antiqua* (if the latter is correctly allocated in time) but it is not at all impossible that the two may be found to occur together since the time separation of the two zones is seemingly not great.

The presumed differences in the character of the teeth of this species and *Hyporhina antiqua* would suggest that a much wider separation between the forms exists than that between species. The living amphisbaenid genera *Trogonophis*, *Pachycalamus*, and *Agamodon* have acrodont teeth. All are African in distribution. Other living forms presumably have pleurodont teeth.

REFERRED MATERIAL

Among the fossils collected by Mr. Edwin C. Galbreath in the Oligocene of Logan County, Colorado, in 1948, are two other specimens that are here regarded as referable to this species: K. U. M. N. H. P. No. 8222 and No. 8219.

No. 8222: This specimen bears the following data: SW¼ of Sec. 12, T. 11N. R54W., Logan County by E. C. Galbreath (field No. 5850). It consists of a skull that retains only a small part of the deflected facial portion, and the greater part of the right side of

the braincase. The front and outer part has been fragmented recently as the broken edges show but little wear. Of the parts present the following characteristics are discernible (Plate LIX, fig. 4):

Frontals.—Only the posterior parts of these elements are present but these are considerable larger than the deflected facial part of the parietal, partially wedged between them.

The surface sculpturing is similar to the type but differs somewhat in details. On the sides there are two or three grooves terminating in deep pits. No fragments of the prefrontals are in evidence but a portion of the orbital vacuity is overhung by the frontal. This edge has a small rounded notch for contact with the prefrontal. An examination of this area discloses no foramen that might serve as a passageway for an optic nerve.

Parietal.—The parts of the parietal that remain, and particularly the posterior extensions on each side of the foramen magnum, resemble the condition in the type. However, on the right side a small thin squamosal element, lying above the otic-occipital region, is larger than a similar element in the type. Abutting against the lower posterior extension of this element is a quadrate in normal, vertical, functioning position. Immediately posterior to the quadrate is the "stapes" with a broad irregularly oval base covering the fenestra ovalis, and a slender columella rising from it to nearly two thirds of the greatest length of the base. The outer termination of the columella is somewhat expanded and may have supported an extra-columella such as obtains in certain living, as well as in certain extinct, forms. On the median line of the parietal at or near the point at which the bone contacts the supraoccipital there is a rather large perforation,* a character evident or suggested in some other fossil skulls, as well as in skulls of living forms.

The basal portion of the skull, from the basioccipital to a point where the anterior extension of the cranial cavity is exposed in a fracture, is a single element composed of (presumably) the basioccipital, basisphenoid and perhaps also a presphenoid. There is no evidence of a break in its continuity. The superficial membrane bones of the palatine region normally present (the prevomers, pterygoids, ectopterygoids, and palatines) are absent, leaving a broad smooth chondral bone terminating anteriorly in three points, of which the median is on a different plane than the other two. It forms a suture with the frontals. Laterally for a considerable portion of its length, the bone forms a suture (not an overlapping)

* Of this opening Rainer Zangerl (1944) says, "space left by removal of cartilaginous part of the anterior supraoccipital prong."

with the orbitosphenoid. Posterior to the frontal a fragment of the upper part of the postorbital is discernible.

The association of this incomplete skull with the species *H. galbreathi* can scarcely be questioned. Measurements of equivalent parts differ only by fractions of a millimeter. The one exception, already mentioned, is the greater distinctness and apparently larger size of the squamosal. This may be due to a partial fusion in the type of a part of this bone to the underlying chondral elements.

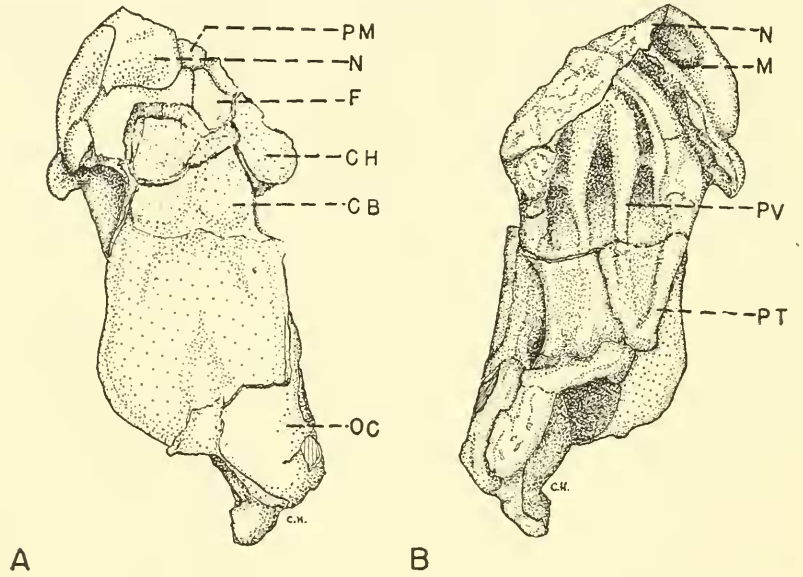

FIG. 3. *Hyporhina galbreathi sp. nov.* (referred material showing part of a cast of the braincase) Kansas U. Mus. Nat. Hist., Paleontology No. 8219. Oligocene, Orellan, Clyde Ward Ranch (SE¼ SW¼ Sec. 12, T. 11N, R. 54W), Logan Co., Colorado. Edwin C. Galbreath, collector. A. Dorsal view; B. Ventral view. Actual length 8.4 mm.

As a result of this the terminal portion of the parietal on either side of the dorsal foramen magnum differs somewhat from the type in contour.

No. 8219: This fragmentary skull taken from the same locality as the previous specimen, is associated with *Hyporhina galbreathi* on the basis of structural similarity of the few elements of the braincase that still remain.

The vomero-palatine region is similar to that of the type save that the posterior palatal prong of the premaxillary is a little longer and slightly more slender. It bears the same general relationship to the premaxillary and maxillary fragment. On the dorsal surface, the

close approximation of the frontals, nasals, and premaxillary to a common medial point obtains, however the premaxillary actually is in contact with the frontals, thus separating the nasals narrowly. A fragment of the postorbital definitely indicates its generic as well as its specific relationship. A bone chip from the dorsal surface, comprising the anterior part of the parietal and the posterior part of the frontals, shows marked similarity of this portion of the skull to this region in the type specimen.

Probably the most significant feature of this specimen is that, due to the removal of much of the roof of the skull, a considerable portion of a cast of the brain is exposed.

In the mesencephalic region a pair of rounded oval corpora bigemina may be distinguished, flanked on either side by the orbital vacuities. This is at the narrowest point of the skull. Immediately following this is a massive area the anterior part of which is trilobulate, and separated from the mesencephalon by sulci. The two outer lobules are relatively narrow; the median broad. Posteriorly, across the middle of this region, there is no trace of lobulation or sulci. Immediately in front of the point of entrance of the foramen magnum there is a broad entrant superficial groove, which lies below a dorsal perforation of the brain case situated on the median line between the parietal and the supraoccipital bones. From this depression a slight epiphysis seems to be present but actually this may be an unnatural accretion of some sort. There is no apparent division into metencephalic and myelencephalic parts.

Anterior to the mesencephalon the cerebral lobes push posteriorly and laterally, terminating immediately in front of the orbital vacuity. This widening of the brain in this region suggests that the telencephalon has somewhat the shape of an arrowhead with the diencephalon and part of the mesencephalon pushing in between the lobes. (Plate LIX, fig. 5).

GENUS RHINEURA Cope

Rhineura Cope, Proc. Acad. Nat. Sci. Phila. 1861, p. 75.

Type species.—Rhineura floridana (Baird).

One living species and six fossil species are recognized.

Rhineura hibbardi sp. nov.

Plate LX, figs. 1, 2, 3; text fig. 4 A, B, C.

Type.—University of Michigan, Museum of Paleontology, no. 25431. Skull with lower jaws; bones on anterior facial portion of skull fragmentary; condyle lacking. Collected by Dr. Claude W. Hibbard and party, August 5, 1947.

Type locality.—Smith Ranch, Logan County, Colorado. Center of Sec. 7, T.11N—R.53W.

Horizon.—Middle Oligocene, White River Formation, Oreodon Zone.

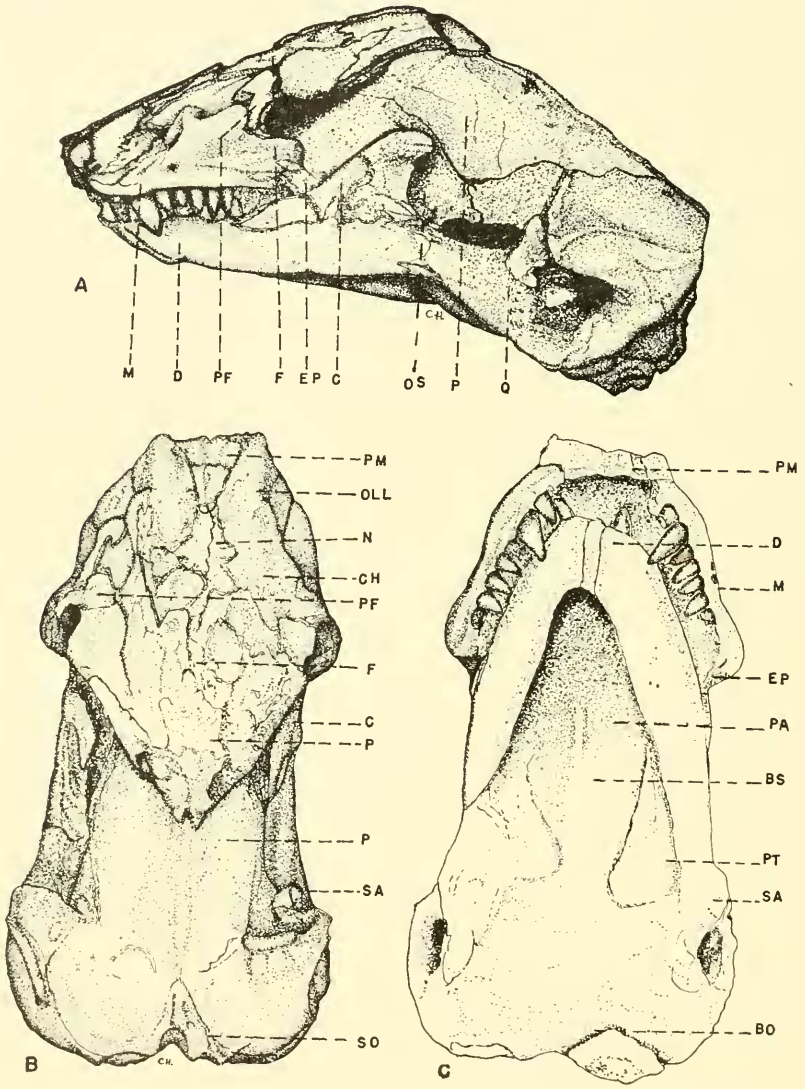

FIG. 4. *Rhinoura hibbardi sp. nov.* Type. Univ. Michigan Mus. Paleo. No. 25431. Oligocene, Orellan, Smith Ranch (center sec. 7, T. 11N, R. 53W), Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, Aug. 5, 1947. A. Lateral view; B. Dorsal view; C. Ventral view. Actual length of fossil 16.6 mm.

Diagnosis.—A large member of the genus *Rhineura,* the skull length reaching approximately 20 mm.; the width of the brain case in the otic region 8 mm.; seven teeth in maxillary, the second largest and somewhat caninelike; seven teeth in dentary, the fourth and first being largest.

Description of the type skull.—The skull at present measures 16.6 mm. from the nasal region to the back of the otic capsule area. The anterior part of the nasals has been largely chipped away, as is true also of most of the premaxilla and the upper parts of the maxillaries; the mold of the brain case appears partially exposed in several places. The olfactory lobes running forward are partially separated by the deeper fragments of the posterior part of the premaxilla, whose suture with the nasals is clearly indicated; the internasal suture can be discerned beginning from the premaxillary, but it can be followed posteriorly for only a short distance. Most of the dorsal surface of the nasals and frontals is missing; however, a few fragments of the frontals display the rugosities and sculpturing typical of the genus *Rhineura.* The outer posterior edge of the frontal overhangs the orbital vacuity for a maximum width of slightly more than two millimeters. The parietal is a saddle-shaped bone, bearing a median sagittal ridge that begins just in front of the foramen magnum, and runs forward and upward for 7 mm. Here the parietal surface becomes suddenly elevated forming a roughened triangular area. Forward of this area the facial part of the skull is deflected abruptly downward. The area of the parietal on this deflected part of the skull consists of a pair of lateral diverging prongs overhanging the orbital vacuities and a forward median extension whose extent cannot be clearly determined. Anterior to the otic capsules the whole brain case is constricted, the parietal extending far down on the sides where it is bordered, anteriorly by the orbitosphenoid and posteriorly by a portion of the occipito-otic complex, that probably corresponds to the prootic. Posteriorly the parietal flairs out but the boundaries with the supraoccipital behind are indistinct and partially broken. For a considerable distance (perhaps half of its entire length) it overlays the bones of the occipital-otic complex. This complex is composed of the supraoccipital, basioccipital, exoccipitals and otic capsules fused seemingly into a single entity, the sutures between the elements being no longer distinguishable. The squamosal is fused solidly to the outer border of the capsule forming a thick overhanging shelf with which the quadrate articulates. The

quadrate is present but has slipped downward exposing its own articular surface. The anterior face of the quadrate rises considerably higher than the articular face, and the whole upper part is normally exposed as a somewhat rounded knob. Covering part of the lower portion of the quadrate is a biscuit-shaped bone, the extracolumella. This bone, seemingly, is not attached; that is, it forms no sutures but is normally held by a ligament from the columella. The fenestra ovalis is large, measuring, on one side of the skull, 2.4 mm. in length, and 2.1 mm. high. The stapes with the columella is missing entirely on the right side, while a portion of the element is present on the left side.

The lower outer face of the maxillaries are more or less complete while the upper surface is chipped away. Five teeth are actually present on the right side with a space between the second and third, and presumably a space following the last, making a total of seven. On the left side there are seven teeth, the first being broken at the base. The second of both series is much enlarged and caninelike. Posteriorly the maxillary joins the ectopterygoid but the actual extent of the suture cannot be traced since the bone itself disappears behind the coronoid. The preoculars lie in front of the orbit and make an undulating suture with the maxillary. They border the whole anterior rim of the orbital vacuities.

Both dentaries are present, each bearing seven teeth of which the fourth is largest. The first tooth of the series is larger than the remaining five. The dentary joins a very large coronoid, which has its beginning anteriorly at the level of the sixth tooth of the dentary series. The greatest length of the coronoid element is more than double its greatest height above the dentary. The dentary and coronoid join the surangular posteriorly, but the details of the sutures are not wholly clear. The surangular bears a notch near its upper center into which the quadrate articulates, while the posterior part of the element bends sharply downward and tends to cover partially the fenestra ovalis.

The basal part of the brain case consists of the basioccipital fused laterally with the exoccipitals, and paroccipitals, and anteriorly with the basisphenoid. The condylar protuberance, save for a small fragment on the left side, is missing. Seen from the ventral surface there is a smooth, relatively deep depression between the points of fusion of the paroccipitals from which point the forward extension of the basal part of the combined element bends downward. A median ridge is evident on the median line; bordering the sides

of the palate (or anterior part of the ventral surface of the brain case) are the pterygoids, which are strongly elevated rather than flat as is the expected position of these bones. Anteriorly they join with the ectopterygoid, and posteriorly they abut against a notch in the side of the basioccipital. Palatines are present as are also the prevomers, but this area of the skull is covered with a hard matrix so most of the significant details cannot be given here.

Measurements in mm.—Estimated length 20. Actual length 16.6 (condyles and tip of snout missing); greatest width of brain case 8.1; least width 4; notch of foramen magnum to point of greatest elevation 7.7; greatest depth of skull and jaws 7.8.

Remarks.—The lateral view of the photograph of the type skull (plate LX, fig. 1) shows the fenestra ovalis, the orbital vacuity, and a point between them intensely black. This is deep shadow only, the skull being intact at these points.

Rhineura amblyceps sp. nov.

Plate LIX, fig. 1; Plate LXI, figs. 1, 2, 3, 4, 5; Plate LXII, figs. 1, 2, 3, 4, 5; text figs. 5 A, B, C., 6 A, B, C.

Type.—University of Kansas Museum of Natural History (Paleo.) No. 7649, consisting of the basal portion of a skull, the anterior facial portion of which, from about the middle of the frontals being entirely absent.

Type locality.—Clyde Ward Ranch, Logan County, Colorado, July 29, 1946.

Horizon.—Middle Oligocene, Orellan, Oreodon Zone.

Diagnosis.—A moderately large species of *Rhineura,* with an estimated total skull length of approximately 18 mm., and the greatest width of the brain case of about 7.7 mm. The orbitosphenoid is separated from the squamosal by a distance more than one half of its length.

Description of the type.—The deflected facial portion of the skull consisting of the posterior parts of the frontals and the anterior part of the parietal, stands at an angle with the dorsal axis of the skull. The sculpturing of the surface is extremely roughened, there being deep pits, grooves, rounded knobs and irregular vermiform elevations. The frontals, incomplete anteriorly, become narrowed somewhat posteriorly, terminating in blunt points. They are separated posteriorly by a triangular forward prolongation of the parietal; the suture between the frontals and parietal being very irregular. The two lateral wings of the anterior part of the parietal form a sinuous suture while the medial part is somewhat dovetailed.

Only after submersion in a clearing fluid can the complete suture be discerned. The portion of the common median frontal suture remaining, measures 3 mm. in length while the greatest length of the remaining parts of the frontal is 4.3 mm. There is no part of the orbit indicated, but the inner part of the orbital vacuity is overhung by the remaining edge of the frontals and the anterior tip of the parietal.

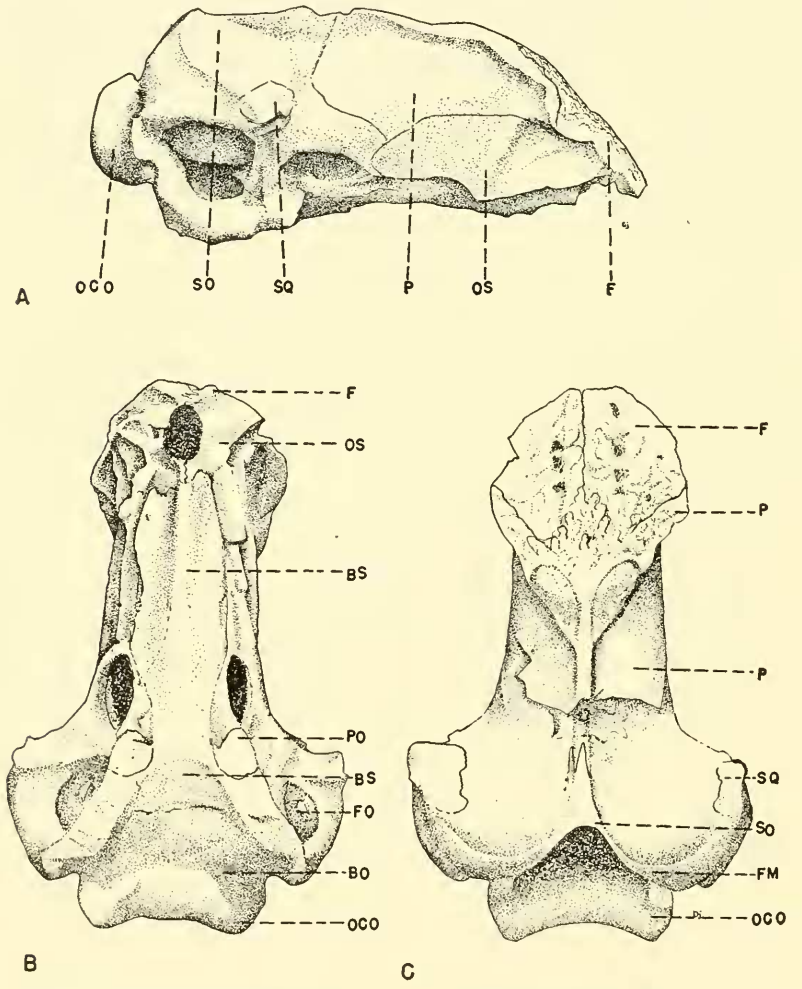

FIG. 5. *Rhineura amblyceps sp. nov.* Type. Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 7469. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, 1946. A. Lateral view; B. Ventral view; C. Dorsal view. Actual length of specimen 12.5 mm.

The parietal is saddle-shaped, flaring broadly posteriorly, bending low on the sides of skull, and reaching forward to the orbital vacuity. The dorsal anterior part is elevated forming an area, triangular in shape with three forward projecting prongs, the two outer are longest and the median widest but shorter than the outer.

There is a median longitudinal ridge beginning near the foramen magnum and running forward to the deflected facial portion of the skull varying in its elevation. In the lower posterior part of the triangular elevated area there are two symmetrical, oval, slightly depressed areas with somewhat roughened surfaces (presumably for attachment of muscles to hold the head at an angle). The posterior extension of the parietal is missing, having been chipped away but there is a depression following the posterior rim of the supraoccipital that seemingly marks its original contours. These form two rounded extensions, separated posteriorly by a median projection from the supraoccipital which dove-tails with the parietal about two millimeters anterior to the forward edge of the foramen magnum. Elsewhere the parietal overlies the combined otic-occipitals, the extent of the overlap at places equaling half the length of the parietal (perhaps more).

The posterior chondrocranial bones of the brain case have fused into a continuous bony complex, composed of the supraoccipital, exoccipitals, basioccipital together with the elements of the otic capsule. On the ventral surface of the brain case the basisphenoid is likewise fused to the combined bone and possibly also a presphenoid (it is presumed that these elements are all distinct in the embryo or young animals). The limits of these various elements is only to be conjectured (save for a remnant of a suture between basioccipital and basisphenoid). (The references to *area* and *region* are based on probable positions of the various elements.) The otic areas are very large and dorsally are surmounted by a thin scalelike bone partially fused, that I regard as the squamosal. The outer edge of this bone is thickened and forms the point of contact for the quadrate (this element is lost in this specimen).

The occipital condyle* is a curved, continuous "roll," with articular lateral knobs or facets. Presumably it is composed of the basioccipital and parts of the exoccipitals. The condyle is elevated strongly leaving the foramen opening almost wholly dorsal, suggesting that the head must be held at an angle for the proper en-

* Since the description was drawn up the skull has suffered certain fractures and the loss of the condyle.

trance of the chord. Anterior to the condyle on the posterior ventral surface, the basioccipital flares out suddenly then narrows gradually to a point in front of the anterior level of the fenestra ovale, where it is notched to receive the posterior ends of the pterygoids; but the sides remain nearly parallel for some distance before the bone terminates in (probably) three points (the tip of this element is missing but the impression is more or less distinct). Anteriorly the bone forms a suture with the orbitosphenoid and along its middle parts with the occipital complex (prootic). Low on the side anterior to the fenestra ovale is a large opening on the side of the skull, bounded above by the prootic and below by the sphenoidal element.

The anterior extension of the cranial cavity is exposed anteriorly. It is surrounded by very heavy bone of the frontal and orbitosphenoid (see text fig. 6, B†).

Measurements in mm. of type.—Total length (estimated) 18; actual length of fossil 12.5; greatest width of braincase 7.7; narrowest width of braincase 3.4.

Referred material.—Univ. Kansas Mus. Nat. Hist. (Paleo.) No. 7650 is referred with doubt to *Rhineura amblyceps.* The braincase is somewhat narrower, and while there are points of resemblance, some differences are discernible. (Plate LXII).

Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 9041. Fragmentary skull. This seems to differ from the other described specimens in having the posterior part of the pterygoids enlarged and much thickened, with a thin, laterally compressed process reaching forward to contact palatine and possibly also the ectopterygoid. A fragment of the lower jaw (surangular) is pushed against the fenestra ovale on the right side. A quadrate is in place, more horizontal than vertical in position (obviously not the normal position). This bone shows some wear. There is no knob-like outer process on its upper forward edge. (Plate LXI).

Michigan Mus. Paleo. No. 25430, Oligocene, Orellan. Red zone and sandstone. Smith pasture, center sec. 7, T.11N, R.53W, Logan Co., Colorado. Actual length 14 mm. (Plate X). Skull, the braincase and facial portion largely complete. This is referred to *Rhineura amblyceps* with some hesitancy. Six teeth are present in the maxillary, the second largest, the last three subequal in size with a suggestion of a diastema between the third and fourth. The lower jaw is fragmentary and two posterior teeth are in place. The quad-

† In this figure the element marked PO (paroccipital) is actually missing. A scar shows its previous position.

rate is nearly vertical and there is a heavy knob-like structure on its upper anterior edge. Running from the lateral floor of the orbital vacuity to the coronoid is an ossified structure suggesting a cylindrical tendon. (Plate LXVII).

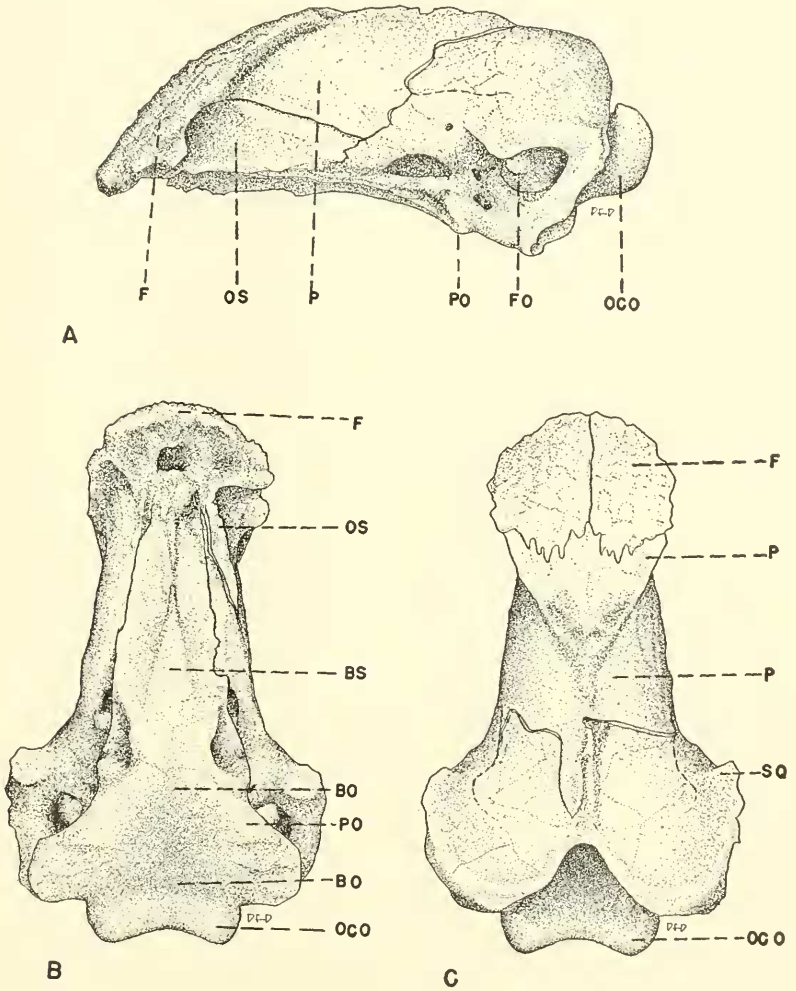

FIG. 6. *Rhinecura amblyceps sp. nov.* Referred specimen. Univ. Kansas Mus. Nat. Hist. (Paleo.) No. 7650. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, July 31, 1946. A. Lateral view; B. Ventral view; C. Dorsal view (relief of sculpturing on frontals not adequately shown). Actual length 11.6 mm.

Rhineura wilsoni sp. nov.

Plate LVIII, figs. 1, 2; Plate LIX, figs. 2, 3; Plate LXIII, figs 1, 2, 3; text fig. 7, A, B, C

Type.—University of Kansas Museum of Natural History, Paleo. No. 7651, consisting of a skull, nearly complete, but lacking squamosal, quadrate, columella, extracolumella, and the entire lower jaws. Collected under the direction of Dr. Claude W. Hibbard, University of Kansas Museum of Natural History Expedition of 1946.

Type locality.—Clyde Ward Ranch, Logan County, Colorado, July 1946.

Horizon.—Middle Oligocene, White River Formation, Oreodon Zone.

Diagnosis.—A species characterized by the small depth of the braincase, elongate prefrontals, and general slenderness of the skull; maxillary teeth 7; nostrils ventral; area lateral to prevomers somewhat inflated. Skull length 14.1. Deflected facial portion of skull practically as wide as greatest posterior width.

Description of the type.—The skull is strongly humped near the middle. The anterior part of the parietal, together with the remainder of the facial portion of the skull being strongly deflected downward. Near the central part of the parietal there is a low sagittal crest developed. This runs forward and terminates at a point where two flattened oval surfaces diverge anteriorly. These two surfaces are presumably points of muscle attachment. These surfaces are slightly depressed but anterior to them the parietal surface becomes very rugose, with pits and grooves, that tend to form a slightly radiating pattern on the frontals. At the posterior end of the sagittal crest of the parietal, the median point is wedged between two points of the forward projecting part of the supraoccipital, which bears a slight median crest. This is flanked laterally by the two broad posterior extensions of the parietals that reach to within one-third millimeter of the superior notch of the foramen magnum; the bones are truncate posteriorly and a part is chipped away but their posterior limit is marked by a low transverse ridge on the supraoccipital. The parietals extend low on the sides of the braincase and form sutures with the prootic and apparently for a very short distance with the orbitosphenoid, and broadly overlies the forward extension of the combined occipital and otic elements which are fused together. The anterior parietal suture with the frontals is intricately dove-tailed with an outer diverging spine that reaches forward perhaps as far as the prefrontal (the edges of the

supraorbital region are chipped and the extent of this element cannot be determined); a prefrontal is present on each side, the anterior part wedged into the maxillary. It is somewhat triangular in shape, however it is likely that portions of the edges of this element are chipped away.

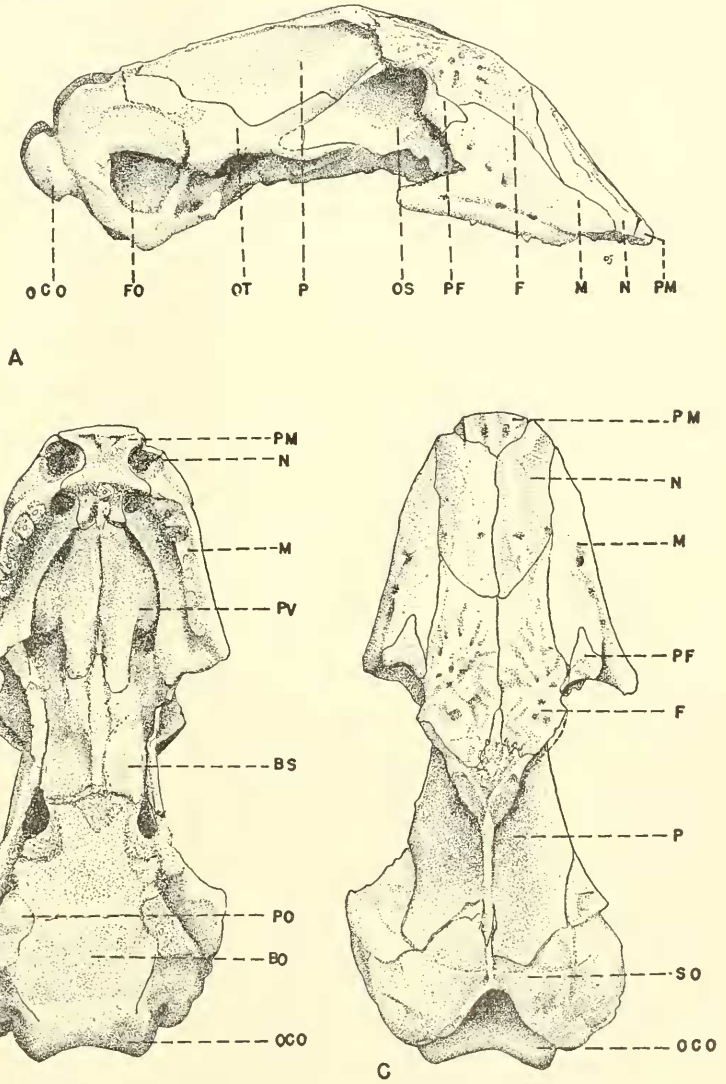

FIG. 7. *Rhineura wilsoni sp. nov.* Type. Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 7649. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, 1946. A. Lateral view; B. Ventral view; C. Dorsal view. Actual length of skull 14.1 mm.

The frontals are once and one half as long as wide, the anterior portions being wedged in between the maxillary and nasals. Nasals are about three times as long as wide, extending to the end of the snout and bending under to form the anterior rim of the nostril. The premaxillary is about $2\frac{1}{2}$ mm. wide on the superior aspect of the snout. On the inferior aspect of snout the premaxillary narrows between the two large nares, but I am uncertain whether they form a part of the rim. Behind nostrils the element widens. The alveolar surface which is more or less directed backward bears a single median tooth. Behind this and on a different level the bone again narrows terminating in two blunt tips in contact with the prevomers.

The maxillary, laterally, rises considerably above the level of the prefrontal and has contact with the prefrontal, frontal and nasal on the superior aspect. Anteriorly a flattened extension of it forms the outer and posterior border of the nostril, and a small curved spinelike projection from it forms most of the inner nostril border. In ventral aspect the maxillary borders the premaxillary, the prevomers anteriorly, and the palatine, ectopterygoid, and apparently also the orbitosphenoid, posteriorly. Three small pits (foramina) are evident on the lateral aspect. A groove or depression passing from nostril is ventral anteriorly, but becomes lateral low on the side. Seen from the ventral aspect the alveolar surface faces slightly inward. Seven teeth are present but only the bases remain, the third and fourth being very much smaller than those preceding or following. A deep pit exists behind the nostril which connects with the groove along the alveolar surface. The broad inner shelf of the maxillary overhangs the outer inflated wings of the prevomers.

The ventral part of the braincase consists of the basioccipital fused laterally with the exoccipitals, paraccipitals, basisphenoid and perhaps a presphenoid. Two lateral notches somewhat in front of the level with the anterior edge of the fenestra ovalis, are for the reception of the posterior extension of the pterygoids. These elements are missing from the skull. It is probable that anteriorly a portion of the palatines remain.

Measurements in mm.—Total length 14.1; greatest width of braincase (through otic region) 6; narrowest width 3.1; greatest width of facial portion of skull 5.8; greatest elevation of braincase 3.7.

Referred material.—A fragmentary specimen, consisting chiefly of a braincase, is referred to this species with doubt. It is Univ. of Michigan Museum of Paleontology No. 25429, Oligocene, Orellan, from Smith Ranch, center sec. 7, T.11N, R.53W, Logan Co., Colo-

rado. It appears to approach *Rhineura wilsoni* closer than it does the other species, and in spite of certain differences, I believe this association the wisest disposition until more material of the forms are available. (Plate LVIII, figs. 1-2; Plate LIX, figs. 2, 3).

Rhineura hatcheri Baur

Plate LXIV, figs. 1, 2, 3; Plate LXV, figs. 1, 2, 3; Plate LXVI; figs 1, 2, 3; text fig. 8

Rhineura hatcheri Baur, Amer. Naturalist, vol. 27, 1893, p. 998, (Type, Princeton University No. 11389, Battle Draw Spring, Washington Co., South Dakota, Leptauchenia Zone); Cope, Rep. U. S. Nat. Mus. 1898 (1900), p. 684; Hay, Bull. U. S. Geol. Surv. No. 179, 1902, p. 476; Eigenmann, Proc. Washington Acad. Sci., vol. 4, Sept. 30, 1902, pp. 533-548, pls. 32-34; Douglass, Annal. Carnegie Mus., vol. 4, nos. 3 & 4, Apr. 1, 1908, pp. 283-284, text figs. 3-5; Nopcsa, Beit. Pal. Geol. Oester.-Ung., vol. 21, 1908, p. 46; Eigenmann, Carnegie Inst. Washington Pub. 104, 1909, p. 48; O'Harra, South Dakota School of Mines, Bull No. 9, p. 121, fig. 20; *ibid.* No. 13, 1920, p. 160; Zittel, and Broili-Schlosser, Gründzüge der Paleontologie, 4 ed., vol. 2, 1923, p. 257, fig. 360; Gilmore, Mem. Nat. Acad. Sci., vol. 22, 3rd memoir, 1928, pp. 35-42, pl. 1, text figs. 17-19; Proc. U. S. Nat. Mus., vol. 86, p. 15, fig. 3; Gilmore and Jepsen, Journ. Paleontology, vol. 19, No. 1, Jan. 1945, p. 31.

This fossil species has had detailed treatment by Gilmore, 1928. I have not had opportunity to examine the referred material, but accept Gilmore's reference of two specimens to the Oreodon beds, Badland Creek, Sioux Co., Nebraska (Carnegie Mus. Nos. 423B and 423C); and one in the Lower Oreodon beds, White River, Oligocene, Cedar Draw, Cheyenne R., Washington Co., S. Dak. (Amer. Mus. Nat. Hist. No. 12226). Whether the faunas of these two places are of identical age as the Orellan of Logan Co., Colorado, remains to be proved. However, it is generally believed that there is no very considerable time interval involved between the three faunas.

In the material at hand I find certain skulls that appear to be referable to the species *Rhineura hatcheri* judging by the published descriptions and figures. These are discussed below.

Univ. Colorado Mus. No. 19852. Cedar Creek phase, White River, Orellan (Middle of west half, sec. 7, T.11N, R.53W, 1½ miles NE of Ward Ranch, 35 miles NW of Sterling, Logan Co., Colo.). This skull is one of the most complete skulls I have examined. Moreover, certain of the chondral bones of the braincase still have sutures evident. Both lower jaws are in place, attached by their respective quadrates, that on the right side has the posterior part of the surangular absent. On the left side the protruding portion of the stapes is missing and the extracolumella is lost from both sides. A portion of the premaxilla has been chipped away.

The nasals are 3.2 mm. long and 1.2 mm. wide anteriorly. A short median posterior projection of the premaxilla tends to separate them anteriorly. The bones show little or no sculpturing or pitting.

The frontals, however, are heavily sculptured on their outer parts with numerous pits (and foramina) while more mesially they show some transverse grooves connecting with pits. They form dovetailed sutures with the anterior part of the parietal along their posterior

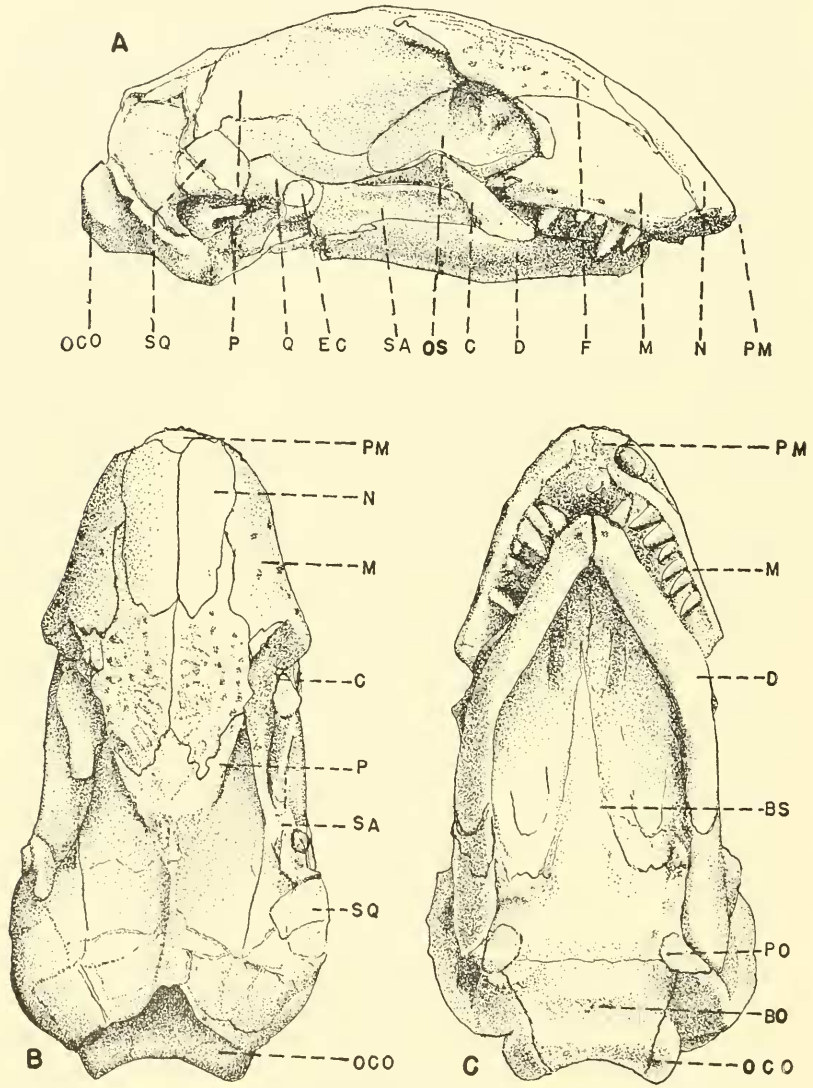

FIG. 8. *Rhinoura hatcherii* Baur. Univ. of Colorado Mus. No. 19852. Oligocene, Orellan (Cedar Creek phase), middle of west half Sec. 7, T. 11N, R. 53W, 1½mi. NE of Ward's Ranch, 35 mi. NW Sterling, Logan Co., Colorado. Dr. Robert Wilson, collector. A. Lateral view; B. Dorsal view; C. Ventral view. Actual length of skull 12.2 mm.

borders. A median anterior parietal projection separates the posterior ends of the frontals. Laterally the frontal overhangs the orbital vacuity above its middle and forms a narrow lateral suture with the prefrontal, and an elongate one with the maxillary; anteriorly an elongate spine projects forward from each frontal separating the nasals, for half their length, from the maxillary.

The parietal is very large, saddle-shaped, with a median sagittal crest (somewhat chipped away) from the anterior border of the dorsal notch of the foramen magnum, and terminating where the elevated portion begins to widen into a roughened triangular area (presumably for muscle attachment). From the anterior edge of this area the facial portion of the skull is deflected downward at an angle. The anterior part of the parietal has a median projection and two lateral arms that extend along the outer edge of the dorsal deflected part of the skull, reaching forward to near the edge of the orbital vacuity. Laterally the anterior part of the parietal reaches to the orbital vacuity. Low on the sides the parietal contacts two bones, the orbitosphenoid anteriorly and the prootic posteriorly. The posterior extension of the parietal is chipped away on both sides but a depression over the otic region suggests that the original limits of the element approached near to the border of the foramen magnum.

The supraoccipital dovetails mesially with the parietal, and on each side the two wings extend forward and laterally, bordering the foramen posteriorly. Normally it is largely covered by the parietal. Laterally the supraoccipital forms sutures with the prootic and the exoccipital.

The exoccipital is clearly defined above the suture, being evident on the left side of the skull (chipped away on the right side). It borders the foramen magnum and extends back to form the outer knob of the condyle, while a projection from the lower part forms the posterior rim of the fenestra ovalis. Its relationship to the region of the fenestra ovalis is not clearly defined. A deep foramen is evident at the lateral base of the condyle. Two of the semicircular canals can be dimly discerned through the transparent bone as whitish stripes. Lying on the anterior part of the exoccipital is a superficial flake of bone, the squamosal, forming a lateral projection for the articulation of the quadrate. The basioccipital is clearly defined on the ventral surface, its sides narrowing and forming the median portion of the occipital condyle. Anteriorly on the ventral surface it forms a suture with the basisphenoid and laterally

with the exoccipital. At the juncture of the three bones is a small, somewhat elongate paroccipital forming the posterior ventral rim of the fenestra ovalis.

The basisphenoid extends forward along the mesial ventral part of the skull, forming sutures with the posterior part of the pterygoids and overlaid by the latter bones and the palatines save for a narrow median pointed part which disappears under the prevomers. I cannot be certain that a separate presphenoid is present. Anteriorly on the palate are the prevomers, the wings of which are not noticeably inflated.

The premaxillary is chipped away but on the ventral portion a single tooth is evident, the base only remaining. The nostrils are ventral, the dorsal rims being formed by the premaxillary, while a spine from the maxillary forms most of the lower edge of the nostril.

The maxillary on the facial surface has a maximum width of 2.1 mm. and a total length of approximately 4 mm. An irregular row of four pits appears near its lower edge, and two or three are present near the middle of its lateral surface. Six teeth are present on the alevolar surface, the second being largest. There is no appreciable diastema in the series. At the posterior end of the maxillary the ectopterygoid is present connecting pterygoid and maxillary.

The dentary is approximately 6 mm. in length, its greatest elevation being about 1.2 mm. It bears seven teeth, the first and fourth being largest. From its dorsal edge arises a coronoid, its base having a length of 1.5 mm. and an elevation of 2 mm. It forms a suture with the inner surface of the surangular. The surangular is elongate extending for nearly half its length behind the articulating fossae. I do not discern a splenial or an angulare since the inner surface of the jaws cannot be seen, as the fossil is now prepared. The quadrate is approaching a vertical position, its width at the fossae being 1 mm., the lower edge rounded; and its greatest length 2 mm., the upper part being divided into a broad surface articulating with the squamosal and a small prong which lies against the prootic. The surface directed toward the fenestra ovale is strongly excavated. The stapes, present on the right side, is an irregular oval with a median columellar prong 1 mm. long, directed forward.

Measurements in mm.—Total length of skull (approximately) 12.6; total length of fossil 12.1; greatest width of brain case 6; greatest width of facial portion 5; greatest depth of skull 4.1. (See plate LXIV, figs. 1, 2, 3.)

Remarks.—The description of this young specimen (regarded as young because of the lack of co-ossification of the chondral bones of the brain case) differs in no significant feature from the descriptions of the type and the figures given by Gilmore (1928). The smaller size of this specimen would seem to indicate an age difference.

I am also referring to the species two other skulls from the same general locality. Univ. of Kansas Nat. Hist. Mus. Paleo. No. 8220 (Plate LXV). The skull has been broken across the middle and the posterior parts are crushed somewhat. The parietal is more complete than in the preceding specimen and extends farther back covering the sutures between the supra- and exoccipital bones. The posterior section of the surangular is present on each side making contact with the quadrate. An extra-columella is present on both sides, closely applied to the posterior excavation (notch) of the quadrate. The sutures between the basioccipital and basisphenoid are present and the tripartite character of the condyle can be discerned. The maxillary teeth are 6-6, the second largest, the fifth a little larger than the adjoining teeth. The measurements approximate very closely those given for the preceding skull.

Univ of Kansas Nat. Hist. Mus. Paleo. No. 8960. Skull nearly complete but with the posterior part of the braincase flattened. The jaws are present, the posterior parts (surangular) being pushed in, covering largely the fenestra ovalis. Sutures between the chondral bones of the braincase can be discerned on the ventral side of the skull, those separating paroccipitals, exoccipitals, basioccipital and parisphenoid being distinct even on the condyle.

The maxillary bears seven teeth and there are seven teeth on the dentary. However, the maxillary teeth seem anomalous. The second upper tooth is largest and is followed by a pair of minute teeth occupying space that would suffice for a tooth of normal size. The last three teeth are subequal, the sixth being a trifle the larger. In the lower jaw there are only six teeth actually present, but a tooth is lost. On the right side the first and third (fourth) are enlarged but a tooth is missing (presumably) behind the first; posterior to the second large tooth there are three subequal teeth, equally spaced. On the left jaw the first and fourth are largest, the two intervening teeth being present. Behind the fourth there is a narrow diastema scarcely large enough to permit a tooth as large as the two posterior of the series. (Plate LXVI.)

The skulls referred to *Rhineura hatcheri* all agree in having the condyle placed close to the lower level of the skull (See text figure

8 this paper; and Gilmore 1928, pl. 1, figs. 2 and 3). This allows the foramen magnum opportunity to face posteriorly more than in certain other species where the condyle is elevated and the foramen magnum is largely dorsal. It would appear that the head of *R. hatcheri* was held less elevated for direct entrance of the spinal chord, than in these species (*amblyceps et al.*).

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(NOTE.—The plates are incorrectly numbered. The plate explanation for plate 14, applies to plate 15, and *vice versa.*)

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PLATE LVIII

FIG. 1. *?Rhineura wilsoni sp. nov.* Referred materials Univ. Michigan Mus. Paleontology No. 25429. Oligocene, Orellan, Smith Ranch, center sec. 7, T. 11N, R. 53W, Logan Co., Colorado. Dr. Claude Hibbard and party, Aug. 5, 1947. Ventral view. Actual length of fossil, 13 mm.

FIG. 2. Same. Dorsal view.

FIG. 3. *Gilmoreia attenuatus sp. nov.* Type. U. S. Nat. Mus. No. 16308. Oligocene, Orellan (Brule), 8 mi. N Douglas, Converse Co., Wyoming. G. P. Sternberg, collector. Dorsal view. Actual length of fossil 7.5 mm.

FIG. 4. Same. Lateral view.

FIG. 5. Same. Ventral view.

FIG. 6. *Hyporhina galbreathi sp. nov.* Type. Kansas U. Mus. Nat. Hist. (Paleo.) No. 8221. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors. Ventral view. Actual length of fossil 8.5 mm.

FIG. 7. Same. Lateral view.

FIG. 8. Same. Dorsal view.

PLATE LVIII

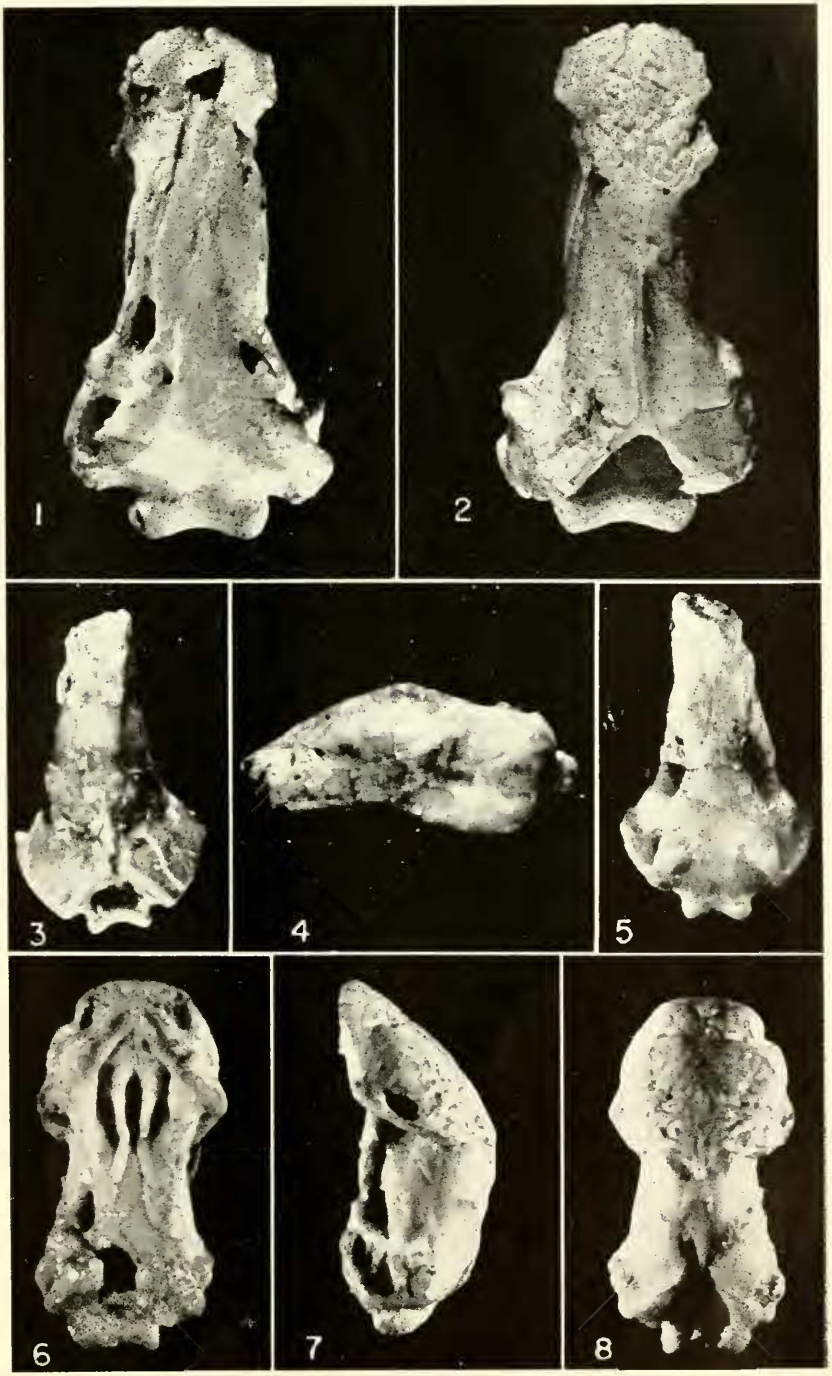

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PLATE LIX

FIG. 1. *?Rhinoura amblyceps sp. nov.* (Referred material) Kansas U. Mus. Nat. Hist. No. 9041. Oligocene, Orellan, Clyde Ward Ranch (W½ sec. 7, T. 11N, R. 53W), Logan Co., Colorado. Edwin C. Galbreath, collector, 1948 Lateral view. Actual length of fossil 10.6 mm.

FIG. 2. *?Rhinoura wilsoni sp. nov.* (Referred material). Univ. Michigan Mus. Paleo. No. 25429. Oligocene, Orellan, Smith Ranch (center sec. 7, T. 11N, R. 53W), Logan Co., Colorado, Dr. Claude Hibbard and party, collectors, Aug. 5, 1947. Lateral view. Actual length of fossil 12 mm.

FIG. 3. Same. Ventral view.

FIG. 4. *Hyporhina galbreathi sp. nov.* (Referred material). Kansas U. Mus. Nat. Hist. (Paleo.) No. 8222. Oligocene, Orellan, Clyde Ward Ranch, SE¼, SW¼, S. 12, T. 11N, R. 54W, Logan Co., Colorado. Edwin C. Galbreath, Collector. Dorsal view. Actual length of fossil 6 mm.

FIG. 5. *Hyporhina galbreathi sp. nov.* (Referred material). Kansas U. Mus. Nat. Hist. (Paleo.) No. 8219. Oligocene, Orellan, Clyde Ward Ranch, SE¼, SW¼, S. 12, T. 11N, R. 54W, Logan Co., Colorado. Edwin C. Galbreath, collector, 1948. Dorsal view. Actual length of fossil 8.4 mm.

PLATE LIX

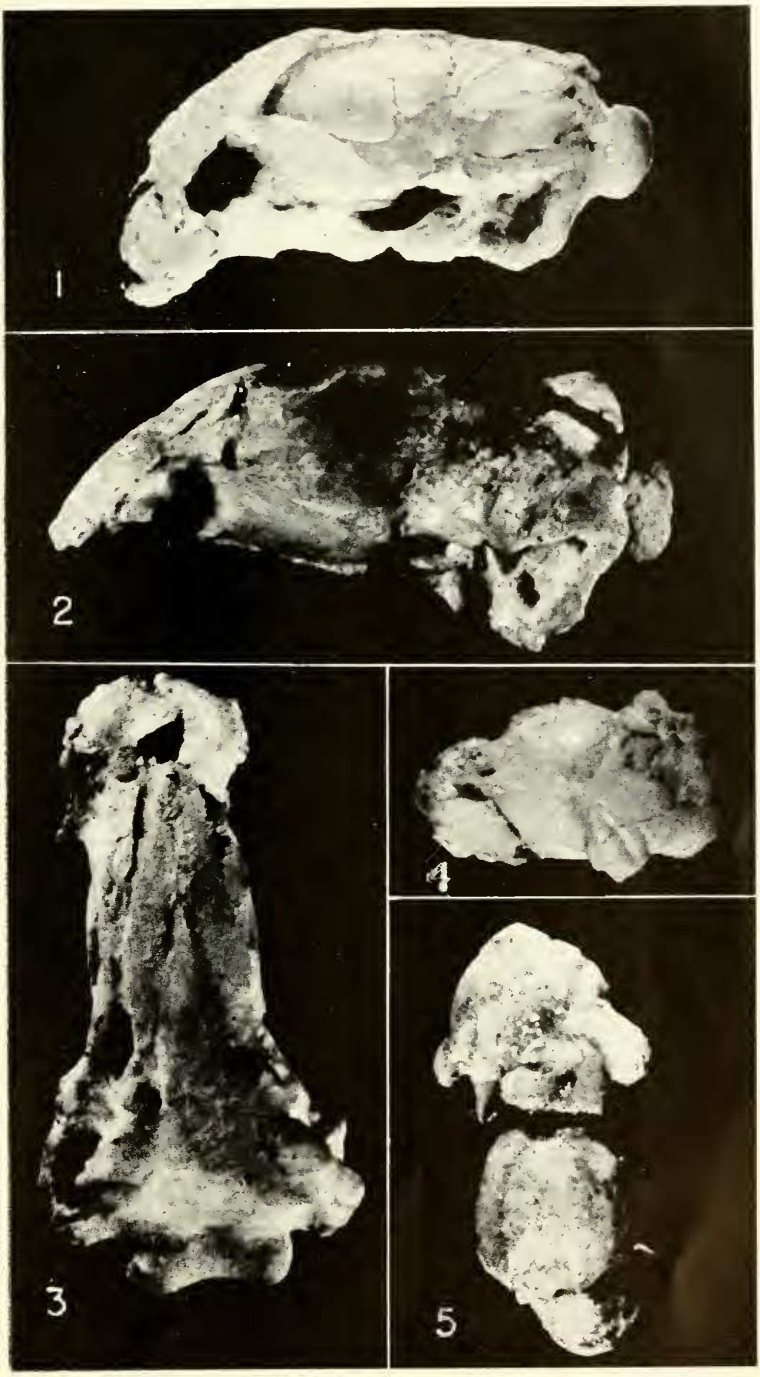

PLATE LX

FIG. 1. *Rhineura hibbardi sp. nov.* Type. Univ. Michigan Mus. Paleo. No. 25431. Oligocene, Orellan, Smith Ranch (center sec. 7, T. 11N, R. 53W), Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, 1947. Lateral view. Actual length of fossil 16.6 mm.

FIG. 2. Same. Dorsal view.

FIG. 3. Same. Ventral view.

PLATE LX

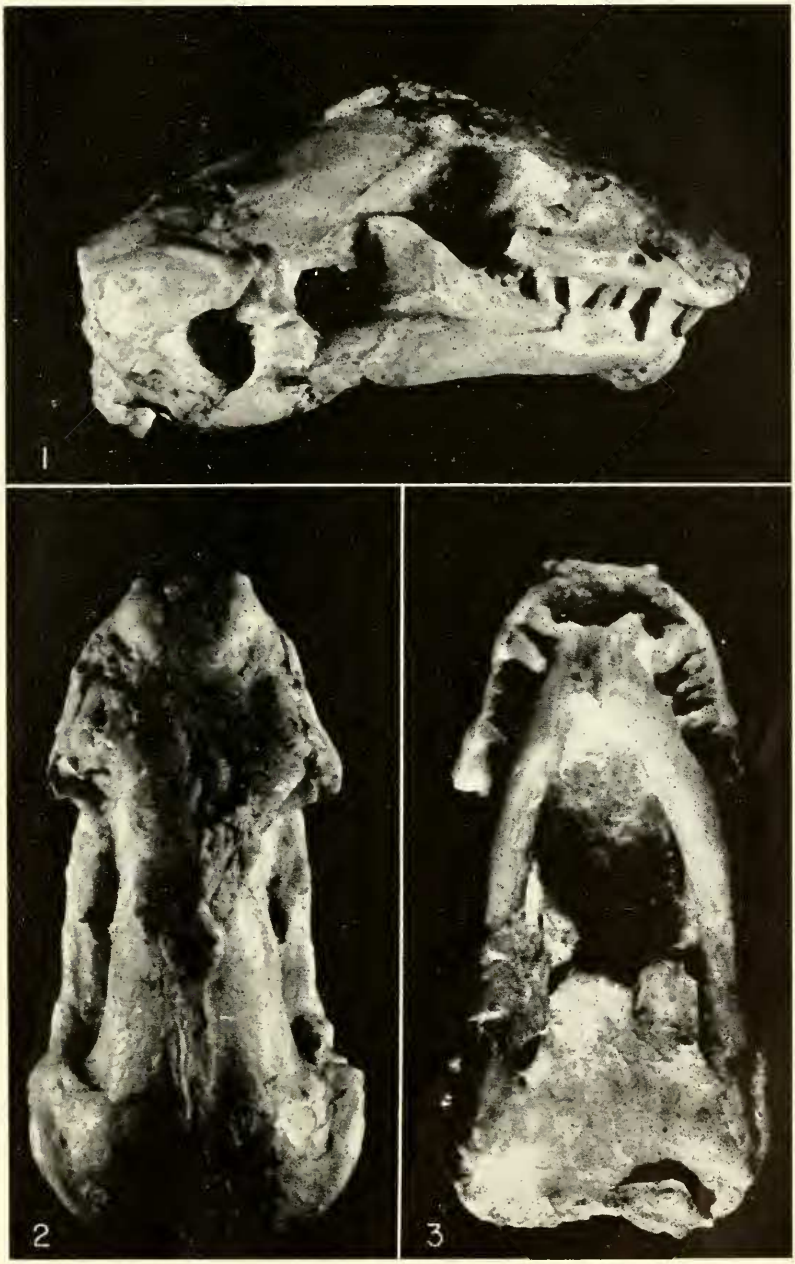

PLATE LXI

FIG. 1. *Rhineura amblyceps sp. nov.* Type. Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 7649. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, 1946. Lateral view. Actual length of fossil 11 mm.

FIG. 2. Same. Ventral view.

FIG. 3. Same. Dorsal view (note figure in text drawn before loss of condyle).

FIG. 4. *?Rhineura amblyceps sp. nov.* (Referred material) Kansas U. Mus. Nat. Hist. No. 9041. Oligocene, Orellan. Clyde Ward Ranch (W½ sec. 7, T. 11N, R. 53W), Logan Co., Colorado. Edwin C. Galbreath, collector, 1948. Ventral view. Actual length of fossil 10.6 mm.

FIG. 5. Same. Dorsal view.

PLATE LXI

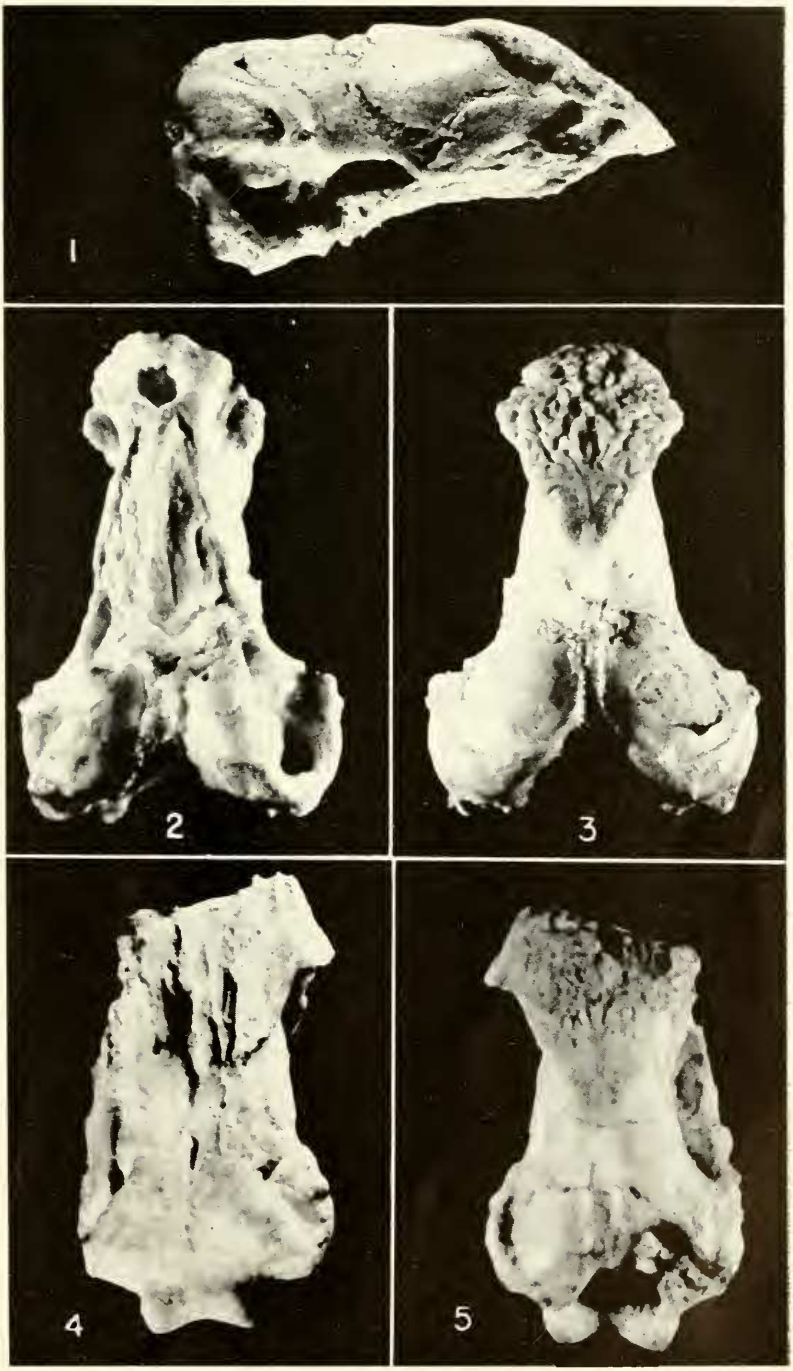

PLATE LXII

FIG. 1. *Rhineura amblyceps sp. nov.* (Referred material) Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 7650. Oligocene, White River (Orellan), Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, July 31, 1946. Lateral view of skull, actual length 12.1 mm.

FIG. 2. Same. Ventral view of skull.

FIG. 3. Same. Dorsal view.

PLATE LXII

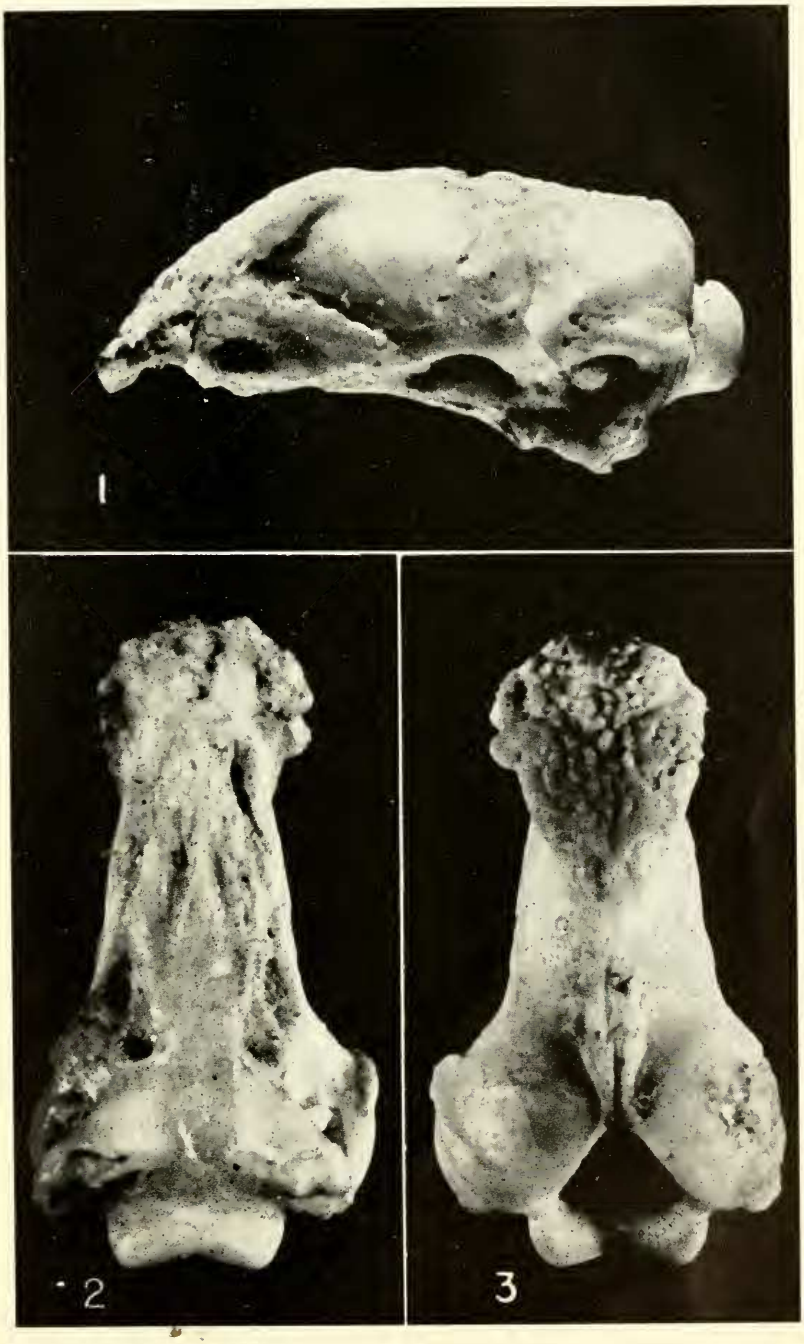

PLATE LXIII

FIG. 1. *Rhineura wilsoni sp. nov.* Type. Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 7649. Oligocene, Orellan, Clyde Ward Ranch, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, 1946. Lateral view. Actual length of skull 14.1 mm.

FIG. 2. Same. Ventral view.

FIG. 3. Same. Dorsal view.

PLATE LXIII

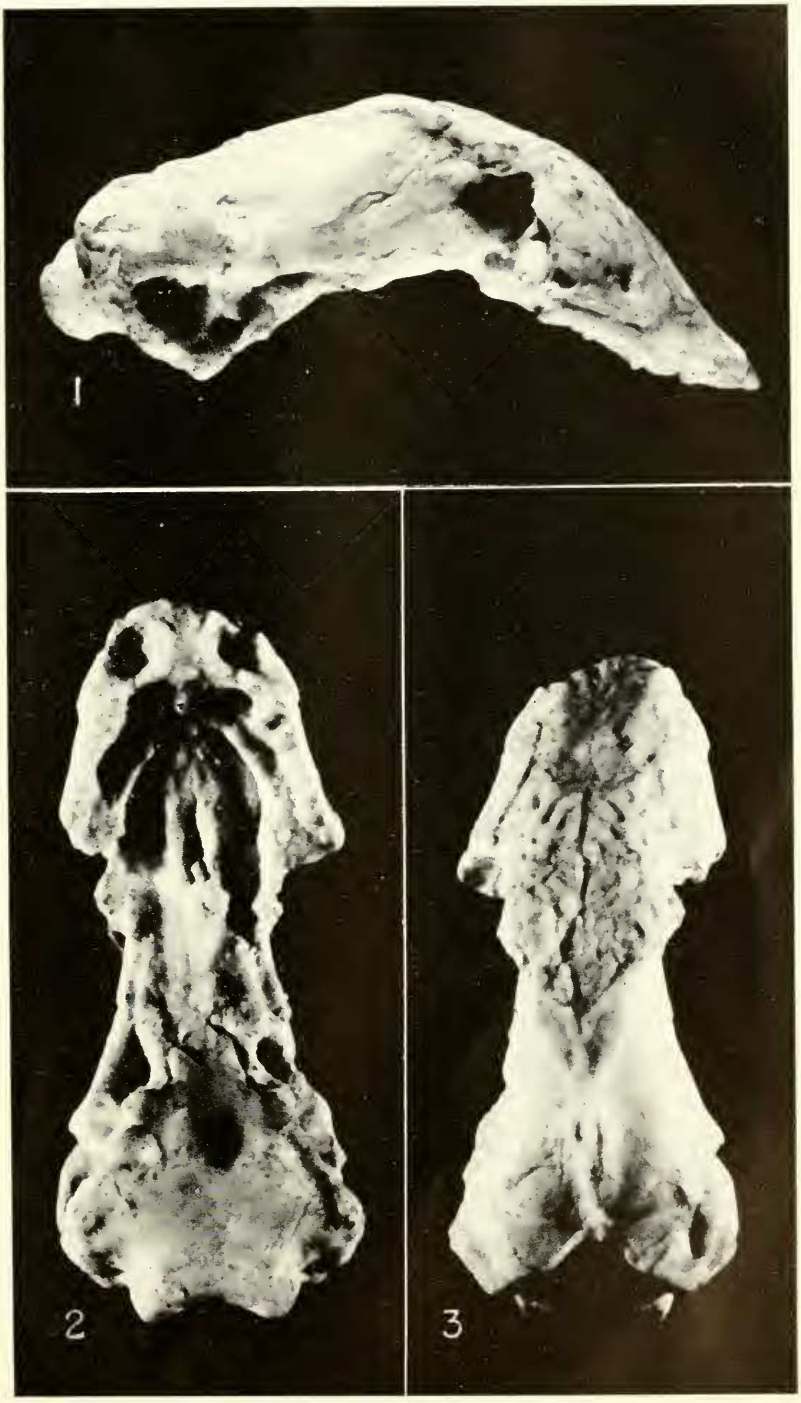

PLATE LXIV

FIG. 1. *Rhineura hatcherii* Baur. (Referred material) Univ. of Colorado Museum (Paleo.) No. 19852. Oligocene, White River (Orellan), Cedar Creek Phase; middle of west half sec. 7, T. 11N, R. 53W, 1½ miles NE of Clyde Ward Ranch, 35 miles NW of Sterling, Logan Co., Colorado. Dr. Robert Wilson, collector, 1940. Lateral view of skull. Actual length of fossil 12.1 mm.

FIG. 2. Same. Ventral view of skull.

FIG. 3. Same. Dorsal view of skull.

PLATE LXIV

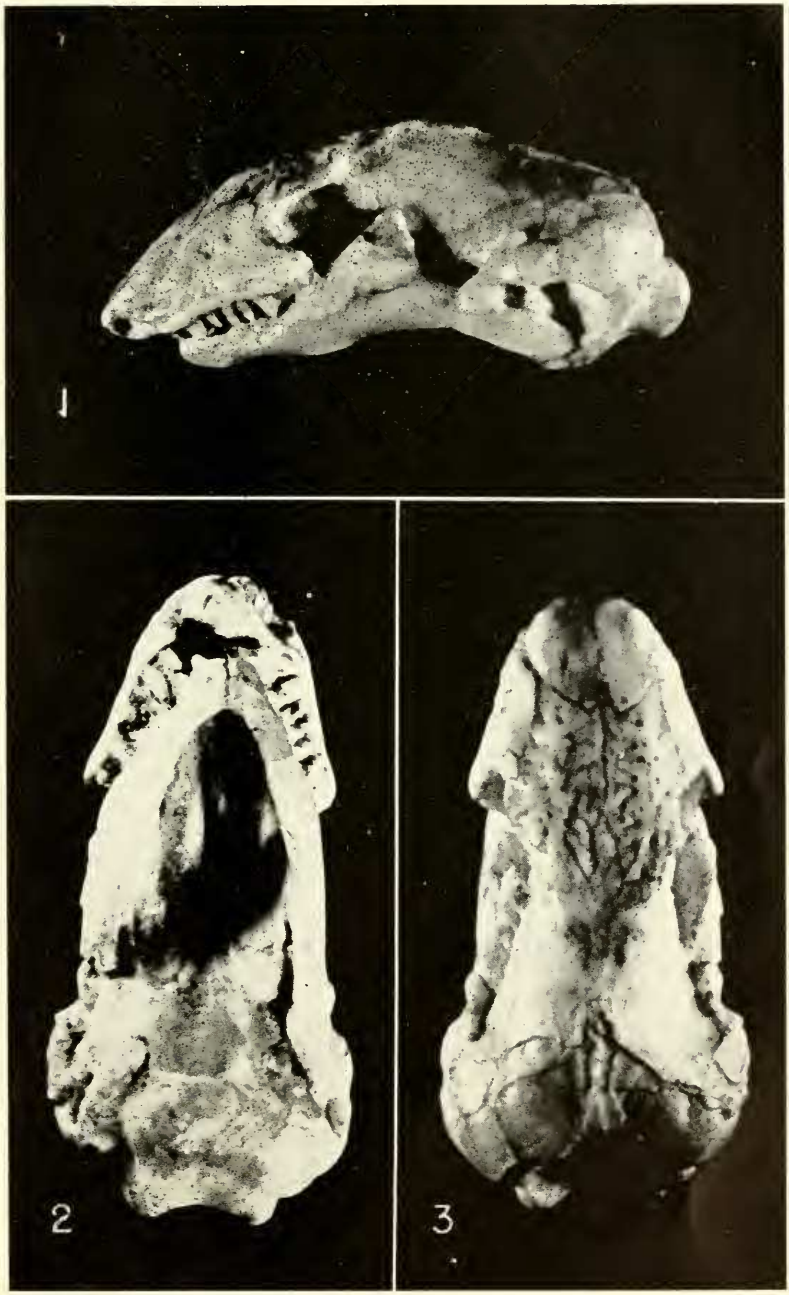

PLATE LXV

FIG. 1. *Rhinoura hatcherii* Baur. (Referred material) Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 8220. Oligocene, Orellan. SE¼, S. 21, T. 11N, R. 53W. Logan Co., Colorado. Edwin C. Galbreath, collector, 1948. Lateral view of skull. Actual length of fossil 12.2 mm.

FIG. 2. Same. Ventral view of skull.

FIG. 3. Same. Dorsal view of skull.

PLATE LXV

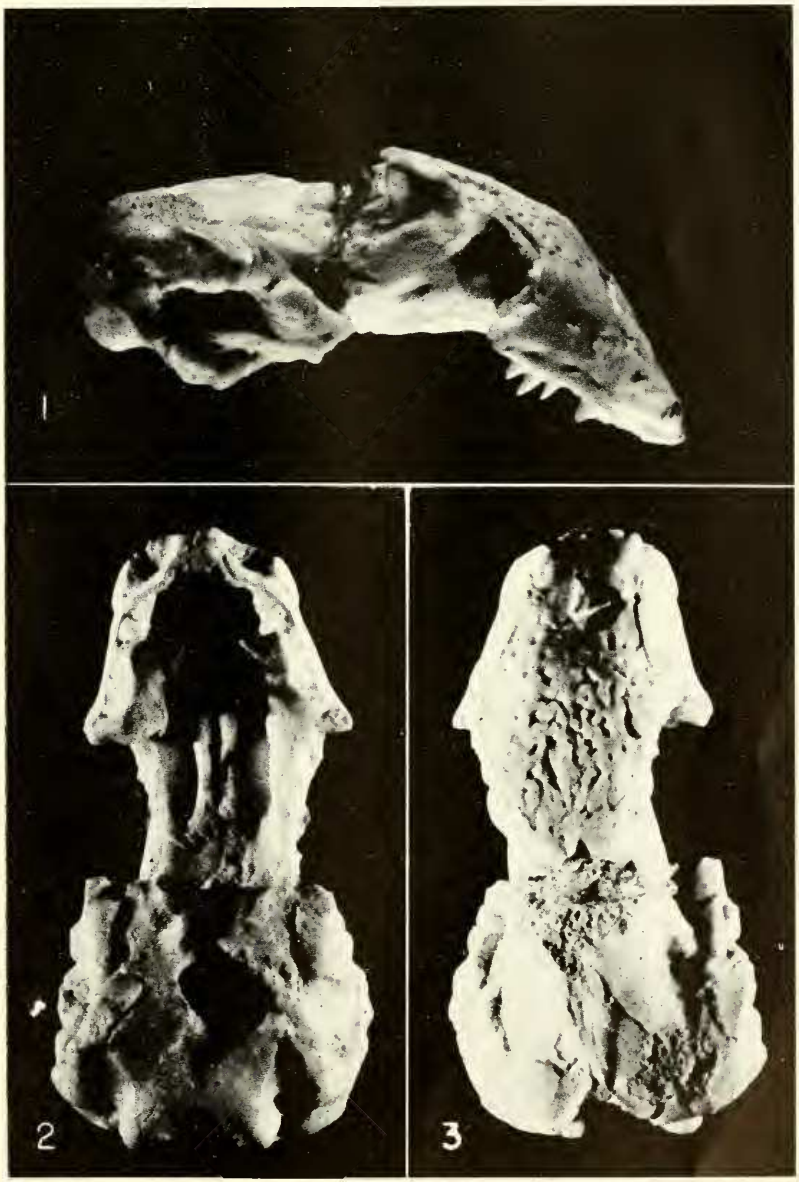

PLATE LXVI

FIG. 1. *Rhineura hatcherii* Baur. (Referred material) Kansas Univ. Mus. Nat. Hist. (Paleo.) No. 8960. Oligocene, Orellan. SE¼, S. 3, T. 11N, R. 54W, Logan Co., Colorado. Edwin C. Galbreath, collector, 1949. Lateral view of skull. Actual length of fossil 12.2 mm.

FIG. 2. Same. Ventral view of skull.

FIG. 3. Same. Dorsal view of skull.

PLATE LXVI

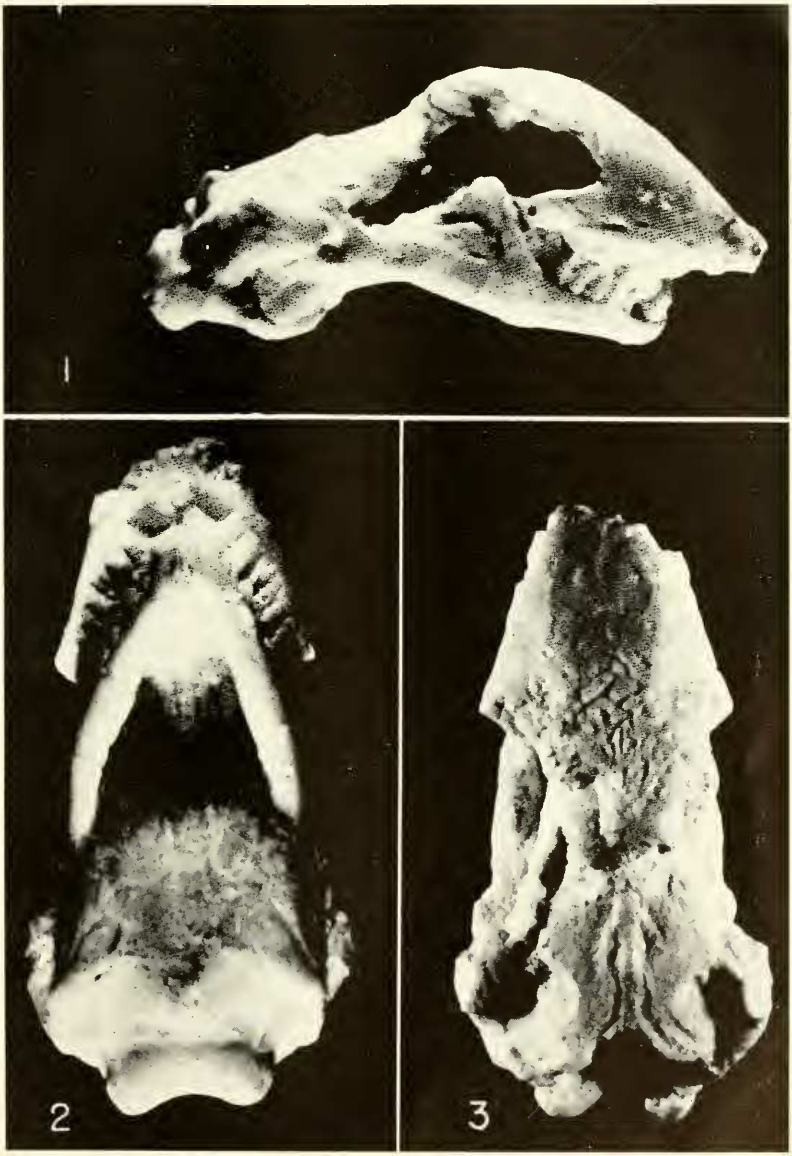

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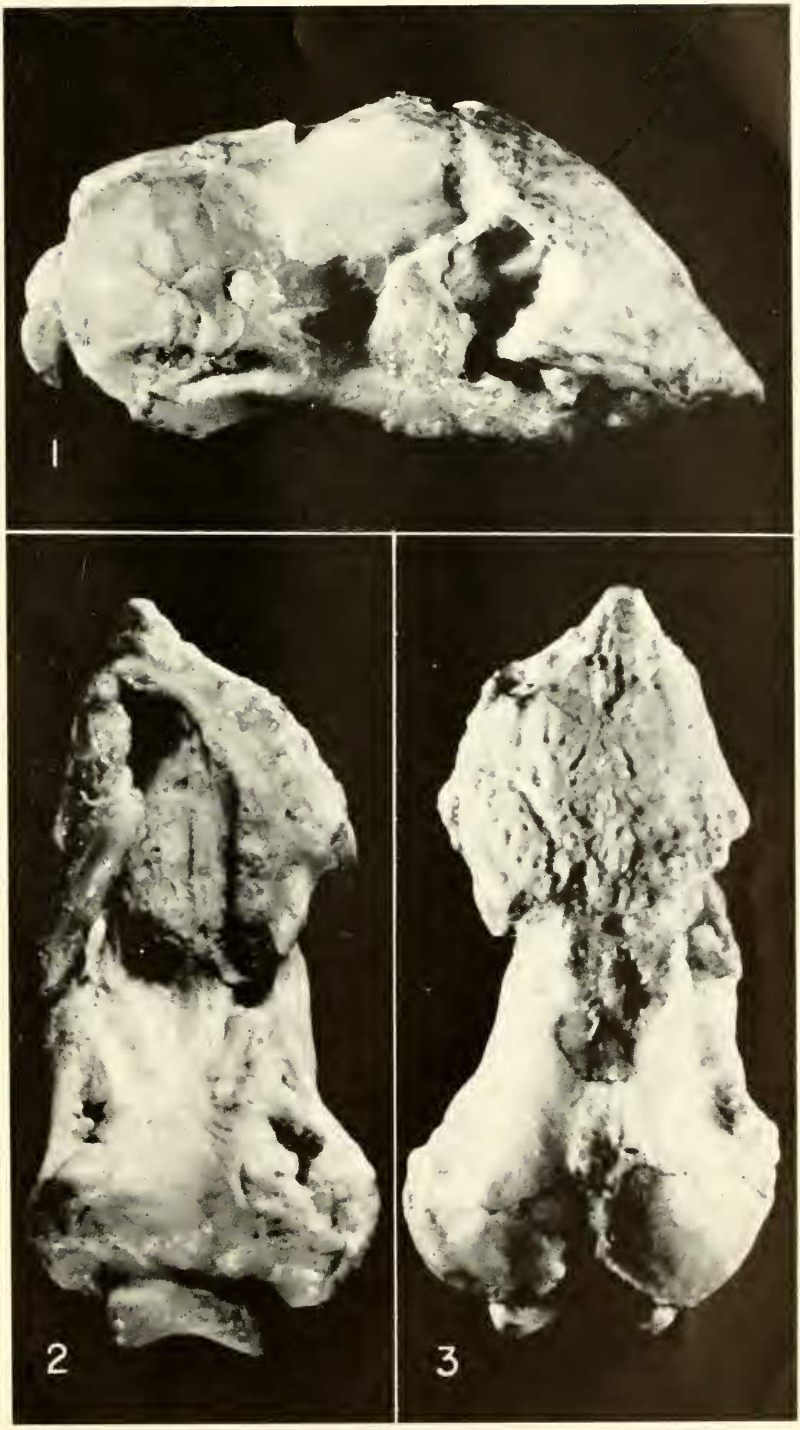
PLATE LXVII

FIG. 1. *?Rhinoura amblyceps.* (Referred material) Univ. Michigan Mus. Paleontology No. 25430. Oligocene, Orellan (Brule), Red zone and Sandstone. Smith pasture, center sec. 7, T. 11N, R. 53W, Logan Co., Colorado. Dr. Claude Hibbard and party, collectors, Aug. 6, 1947. Lateral view of skull. Actual length of fossil 14 mm.

FIG. 2. Same. Ventral view of skull.

FIG. 3. Same. Dorsal view of skull.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